UNITED STATES AIR FORCE

611TH AIR SUPPORT GROUP
611TH CIVIL ENGINEER SQUADRON
ELMENDORF AFB, ALASKA

FINAL QUALITY ASSURANCE PROJECT PLAN

INSTALLATION RESTORATION PROGRAM (IRP) REMEDIAL INVESTIGATION/ FEASIBILITY STUDY

KOTZEBUE LONG RANGE RADAR STATION, ALASKA

OCTOBER 1994

VOLUME I

QAPP & APPENDIX A

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Radar Station, Alaska

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VOLUME 1 QAPP & APPENDIX A

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This Quality Assurance Project Plan describes relevant quality assurance/quality control (QA/QC) procedures to be used by Analytical Resources, Inc. for the Installation Restoration Program at Kotzebue Long Range Radar Station, Alaska.

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1.0 INTRODUCTION

This is the Quality Assurance Project Plan for the Kotzebue Long Range Radar Station (LRRS), Alaska. This Quality Assurance Project Plan (QAPP) describes quality assurance (QA) and quality control (QC) procedures to be used to accomplish the Installation Restoration Program (IRP) Remedial Investigation/ Feasibility Study (RI/FS) at Kotzebue LRRS. The investigation of Kotzebue LRRS will be conducted to evaluate potential hazardous waste contamination at that site and potential impacts to human health and the environment.

This QAPP is written as a companion document to the Field Sampling Plan (FSP) that together comprise the *Draft Sampling and Analysis Plan (SAP), Installation Restoration Program (IRP), Remedial Investigation/Feasibility Study, Kotzebue Long Range Radar Station, Alaska*. This QAPP describes the QA/QC procedures used for analytical work performed by Analytical Resources, Inc. (hereinafter referred to as ARI), as well as the procedures used for the collection and management of data generated during the RI/FS process at Kotzebue LRRS. All the information in this chapter was prepared according to the May 1991 version of the *Handbook to Support the Installation Restoration Program (IRP) Statements of Work, Volume I - Remedial Investigations/ Feasibility Studies (RI/FS)* (U.S. Air Force Reprint, 22 May 1992) (hereinafter referred to as the *Handbook*).

1.1 OBJECTIVES AND PURPOSE OF THE INSTALLATION RESTORATION PROGRAM

The objective of the U.S. Air Force IRP is to assess past hazardous waste disposal and spill sites at U.S. Air Force installations, and to develop remedial actions consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) for those sites which pose a threat to human health and welfare or the environment. Over the years, requirements of the IRP have been developed so that Department of Defense (DOD) compliance with federal laws such as the Resource Conservation and Recovery Act (RCRA), NCP, Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and Superfund Amendments and Reauthorization Act (SARA) could be met.

To ensure compliance with the following regulations, the DOD developed the IRP. The IRP was initiated so that DOD could identify potentially contaminated sites, investigate these sites, and evaluate and select remedial actions for potentially contaminated facilities.

The NCP was issued in 1980 to provide response guidance and a process by which contaminant releases could be reported, contamination could be identified and quantified, and remedial actions could be selected. The NCP describes the responsibility of federal and state governments, and those responsible for contaminant releases.

In 1980, Congress enacted CERCLA. CERCLA outlines the responsibility for identifying and remediating contaminated sites in the United States and its possessions. CERCLA identified the EPA as the primary policy and enforcement agency regarding contaminated sites. Executive Order 12316, adopted in 1981, gave various federal agencies, including the DOD, the responsibility to act as lead agencies to conduct investigations and implement remedial efforts when they are the sole or co-contributor to contamination on or off their properties.

SARA of 1986 extends the requirements of CERCLA, and modifies CERCLA with respect to goals for remediation and the process leading to the selection of a remedial process. Under SARA, technologies that provide permanent removal or destruction of a contaminant are preferable to action which only contains or isolates the contaminant. SARA also provides for greater interaction with the public and state agencies, and extends the EPA's role in evaluating health risks associated with contamination. Under SARA, early determination of Applicable or Relevant and Appropriate Requirements (ARARs) is required, and potential remediation alternatives should be considered at the initiation of an RI/FS. SARA is the primary legislation governing remedial action at past hazardous waste disposal sites.

The IRP is the DOD's primary mechanism for response actions on U.S. Air Force installations affected by the provisions of SARA. In November 1986, in response to SARA and other EPA interim guidance, the U.S. Air Force modified the IRP to provide for an RI/FS program. The IRP was designed so that the RI/FS would be conducted as parallel activities rather than serial activities. The program now includes ARAR determinations, identification and screening of technologies, and development of alternatives. The

IRP may include multiple field activities and pilot studies prior to detailed final analysis of alternatives. Over the years, requirements of the IRP have been developed to ensure DOD compliance with federal laws such as NCP, CERCLA, and SARA.

The objectives of the IRP are to:

- Identify and evaluate sites where contamination may be present on DOD property because of past hazardous waste disposal practices or spills;

- Control the migration of hazardous contaminants; and

- Control health hazards or hazards to the environment that may result from past DOD disposal operations.

The IRP was developed so that these objectives could be met in accordance with CERCLA, NCP, and SARA. Solutions that are developed should provide the level of protection necessary to protect public health and the environment, meet requirements of ARARs, and be technically feasible to implement at a site.

1.2 PURPOSE AND SCOPE OF THE QUALITY ASSURANCE PROJECT PLAN

This *QAPP* outlines QA/QC methods for analytical, and data management aspects of the RI/FS activities at the Kotzebue LRRS. This *QAPP* portion of the *SAP* is a companion document to the *Draft Work Plan, Installation Restoration Program (IRP), Kotzebue Long Range Radar Station, Alaska* (Tetra Tech, Inc. 1994) (hereinafter called the *Work Plan*) and contains a discussion of the following topics:

- QA objectives for data precision, accuracy, completeness, representativeness, and comparability;

- Calibration procedures, references, and frequencies;

- Sampling, laboratory, and Chain-of-Custody procedures;
- Procedures to assess data precision, accuracy, completeness, representativeness, and comparability;
- Corrective actions specific to ARI; and
- QA reports.

2.0 PROJECT DESCRIPTION

Tetra Tech, Inc., under contract to the United States Department of the Air Force (USAF), has been requested to conduct a remedial investigation/feasibility study (RI/FS) at the Kotzebue Long Range Radar Station (LRRS), Kotzebue, Alaska. The RI/FS will be conducted under the authority of the USAF Installation Restoration Program (IRP) and under direction of the Air Force Center for Environmental Excellence (AFCEE).

The RI/FS process includes a scoping task to define data requirements and objectives, a remedial investigation to characterize sites and support a baseline risk assessment, and a feasibility study to define and evaluate available remedial alternatives to support the selection of specific remedial actions. The RI/FS process can be conducted in stages that focus on particular aspects of each process. A Stage 1 and Stage 2 IRP RI/FS have been previously conducted at Kotzebue LRRS as described in Section 2.1, Project Background. However, remaining concerns regarding current site conditions necessitate further site investigation and remedial response in order to achieve environmental restoration at Kotzebue LRRS. This section summarizes project background information, describes general project objectives and scope, and identifies subcontractors and their roles during the proposed IRP RI/FS activities.

2.1 PROJECT BACKGROUND

This section presents a description of Kotzebue LRRS, a summary of past IRP work conducted at the installation, and a description of the recent site survey conducted by Tetra Tech and Air Force personnel at Kotzebue LRRS.

2.1.1 Installation Description

Kotzebue LRRS is located on 676 acres of land adjacent to Kotzebue Sound. The installation is located approximately 610 miles northwest of Anchorage and 450 miles west-northwest of Fairbanks (Figure 2-1).

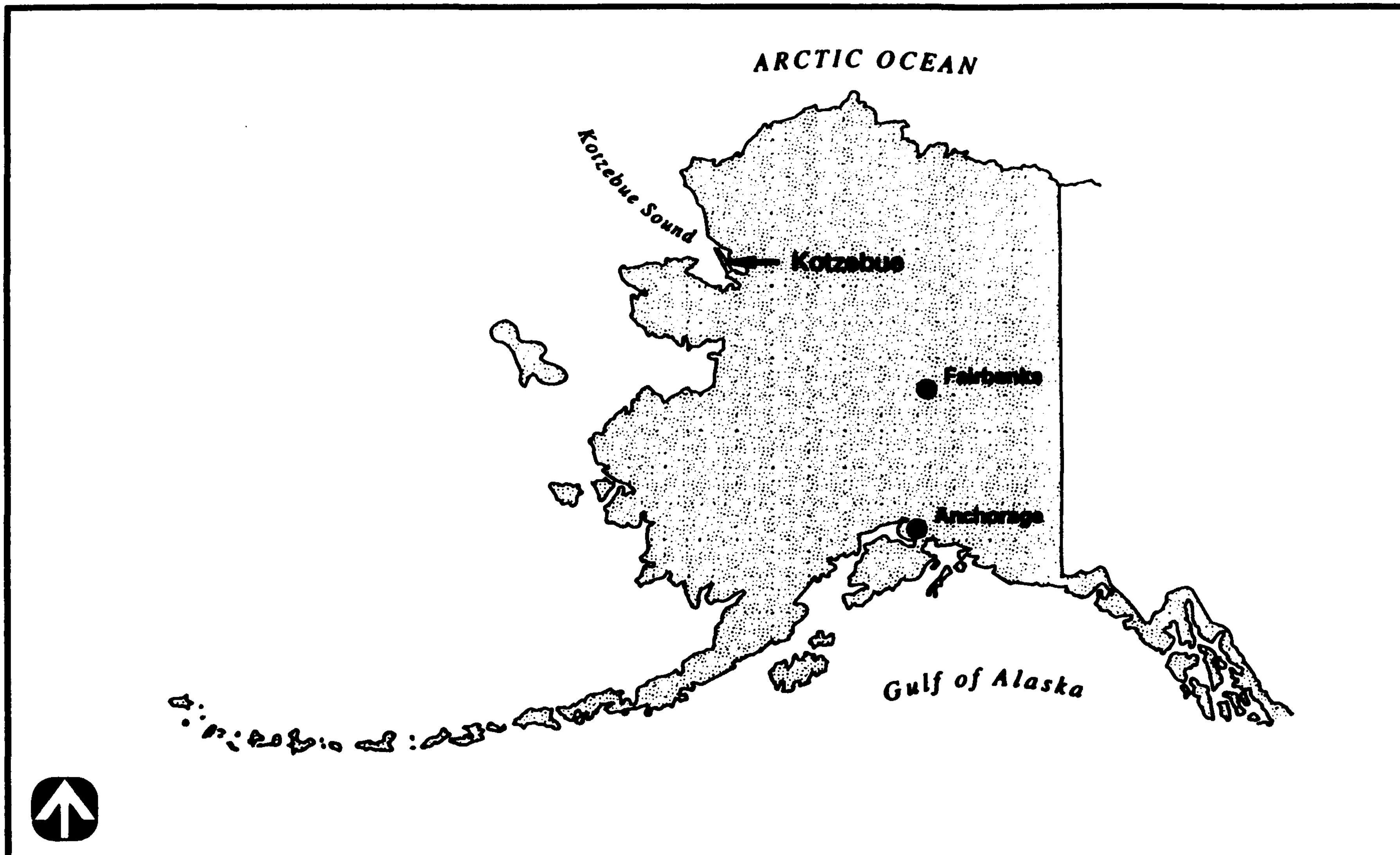

Figure 2-1. Location Map, Kotzebue, Alaska.

The City of Kotzebue, Alaska, accessible by road 4 miles north of the site, has a population of approximately 3600 (Figure 2-2).

Kotzebue LRRS was originally built as a temporary aircraft control and warning site to fill a radar coverage gap while two permanent sites were being built at Cape Lisburne and Tin City, Alaska. Kotzebue LRRS was equipped with a lightweight search radar when it first became operational in 1950. In 1954, the Alaskan Air Command (AAC) decided to convert the site into a permanent station. Construction of permanent facilities was completed in 1958. Kotzebue operated as a ground-controlled intercept site until 1973, when it was converted to a North American Air Defense Command (NORAD) surveillance station. Communications for Kotzebue LRRS were provided by White Alice Communication Systems (WACS) from 1957 until 1979, when a commercial satellite station replaced WACS. In 1977, AAC signed a base operating support contract with RCA Services as part of an Air Force-wide effort to reduce remote tours. Sixty-nine military positions were eliminated and 16 operations positions remained. Installation of Joint Surveillance System (JSS) equipment was completed in 1982, enabling radar and beacon data to be transmitted by satellite to the Elmendorf Region Operations Control Center (ROCC). These operation modifications left only contractor personnel to maintain the radar. A Minimally Attended Radar (MAR) system was installed in 1985 that enabled deactivation of the site, with the exception of the radome. Radar maintenance technicians are currently housed in the nearby City of Kotzebue (WCC 1990a). Figure 2-3 provides an illustration of the Kotzebue LRRS facility.

Past operations such as radar and vehicle shop maintenance at Kotzebue LRRS generated wastes, including waste oils and spent solvents. Waste oils were drummed and stored in waste accumulation areas within facility boundaries. Some waste oils were used for ground application (dust control) on roads. A waste accumulation area and installation landfill, both located adjacent to Kotzebue Sound, were used to store and dispose of facility wastes. Potential contaminants associated with base operations include waste oil, fuels, solvents, herbicides, and pesticides. In 1972, the waste accumulation area was closed, and in 1974 the landfill was closed. The waste accumulation area and landfill were cleaned and regraded, and drummed wastes were removed from the installation in 1975. Fuels management at Kotzebue LRRS included diesel fuel storage in large above-ground storage tanks located adjacent to Kotzebue Sound. These tanks provided fuel to smaller fuel tanks located adjacent to the composite facility. The beach fuel storage tanks were removed in 1992, and the smaller fuel tanks located adjacent to the composite facility are still in place.

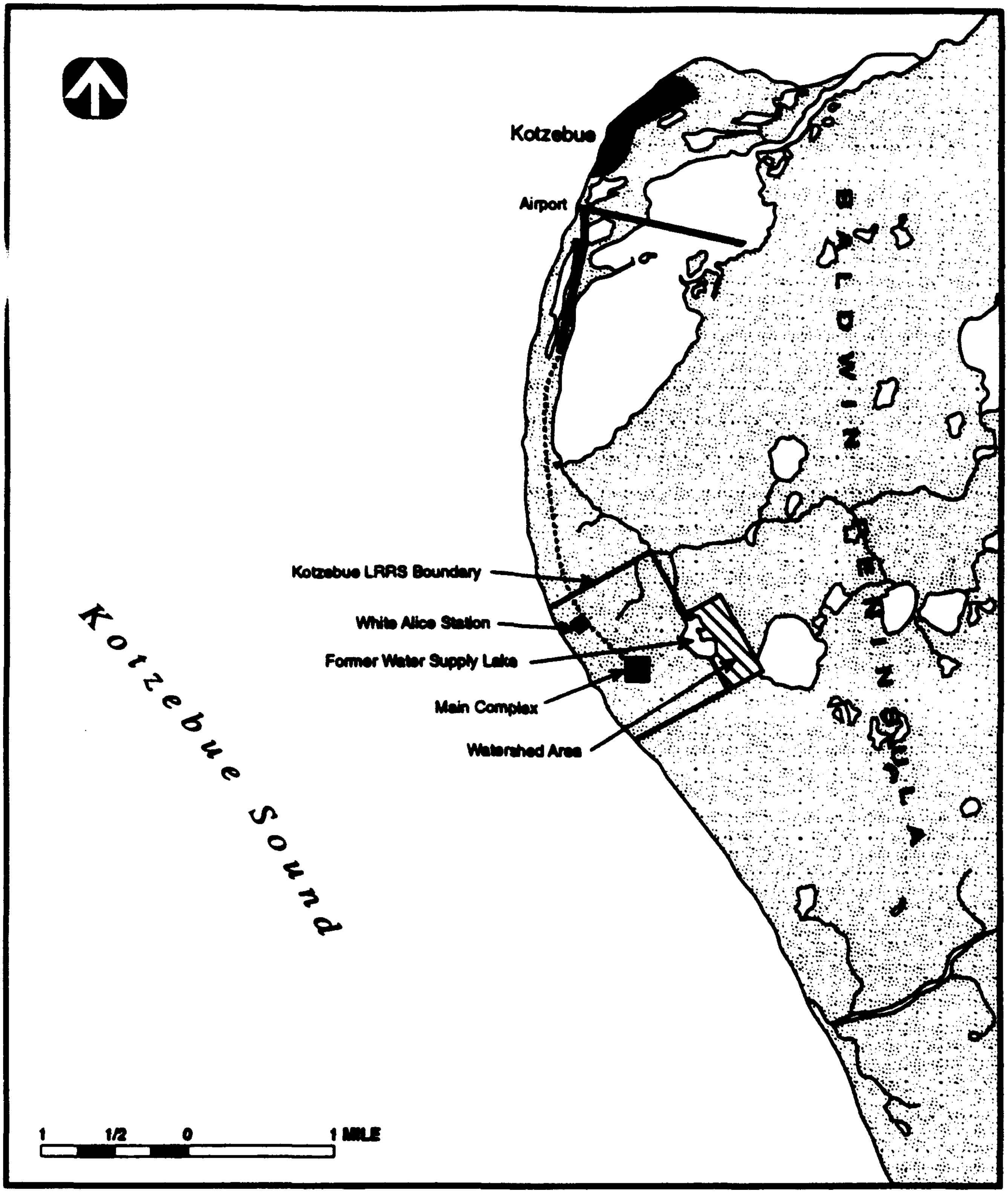

Figure 2-2. Area Location Map, Kotzebue Long Range Radar Station (LRRS), Alaska.

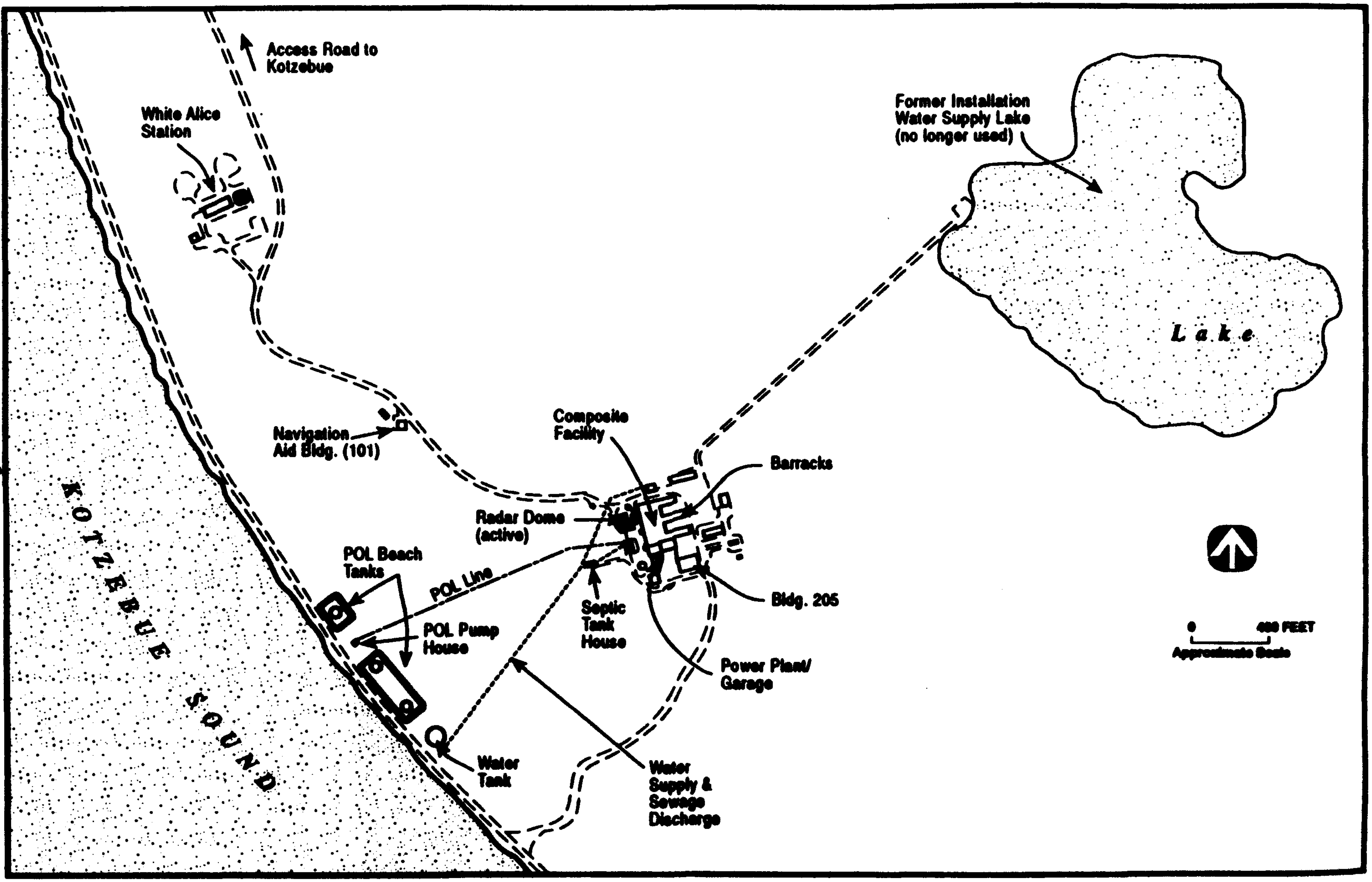

Figure 2-3. Facility Map. Kotzebue LRRS, Alaska.

2.1.2 Previous Investigative Activities and Documentation

This section provides a chronologic summary of past to present IRP activities conducted at Kotzebue LRRS. Summary tables and figures are presented to identify and describe sites, and to provide a common frame of reference regarding all past environmental characterization and associated analytical results obtained for Kotzebue LRRS.

2.1.2.1 Phase I Records Search. In 1985, Engineering - Science (ES) conducted a Phase I Records Search for the AAC Northern Region, which includes Kotzebue LRRS. The purpose of the Phase I records search was to identify and prioritize past disposal sites that may pose a hazard to public health or the environment as a result of contaminant migration to surface water or groundwater, and to identify contaminants that could have an adverse effect due to their persistence in the environment. Twelve sites were identified from a review of base records, interviews with current and former employees, information gathered during field surveys, and from interviews with local, state, and federal agency representatives. Based on an additional assessment of factors such as site characteristics, waste characteristics, and the potential for contaminant migration, eight sites were identified for further IRP evaluation (ES 1985).

2.1.2.2 Stage 1 RI/FS. In 1988, Woodward-Clyde Consultants (WCC) conducted a Stage 1 Remedial Investigation/Feasibility Study (RI/FS) to assess past hazardous materials disposal and spill sites at Kotzebue LRRS, and to develop remedial action(s) for sites thought to pose a threat to human health and welfare or to the environment. Twelve sites were initially identified for investigation by WCC, including the eight sites previously identified during the Phase I Records Search. Based on a 1987 field reconnaissance conducted by WCC and USAF personnel, two sites were excluded from investigation based on a lack of evidence regarding contamination and environmental stress (WCC 1990a). Table 2-1 provides a description of sites identified by WCC. Figure 2-4 provides an installation diagram identifying site locations.

The Stage 1 RI was conducted at 10 sites, and included soil/sediment sampling at all sites, surface water sampling at site SS07-Lake, a soil gas survey conducted at the SS12-Spills No. 2 and 3 sites, water-flooding pilot testing at the SS12-Spill No. 3 site, and aeration of soils at the SS11-Fuel Spill site.

TABLE 2-1. 1988 STAGE 1 RI/FS SITE IDENTIFICATION

USAF Site Designation[a]	WCC Site Designation	Site Name	Site Descriptions
SS01	KOT-4	Waste Accumulation Area No. 1	This site is located south of Building No. 205, west of the installation access road. The site is an approximate 80x160 ft gravel pad formerly used to store drummed waste oils and/or solvents.
SD03	KOT-3	Road Oiling	Waste oils, spent solvents, ethylene glycol, and other shop wastes were reportedly used for dust control on the installation road system. The use of waste oil for dust control was practiced until 1984.
ST05	KOT-8	Beach Tanks	The site is located approximately 0.25 miles southwest of the Composite Facility. The site is associated with the former POL (diesel fuel) storage tanks located adjacent to Kotzebue Sound and comprises an area of approximately 250x900 ft.
SS07	KOT-7	Lake	The lake is located approximately 0.25 miles northeast of the Composite Facility. The lake served as the installation drinking water supply until 1985.
SS08	KOT-6	Barracks Pad	The site is located adjacent to the Composite Facility, between two building wings. The site is an approximate 25 x 40 ft gravel pad reportedly used to store chemicals such as solvents, rust inhibitors, chlorobromomethane, and various fluorocarbons. Small above ground diesel fuel tanks located adjacent to the barracks pad are reportedly a potential source of diesel fuel contamination.
SS09	KOT-5	PCB Spill	The site is located at the White Alice Station, approximately 0.5 miles northwest of the Composite Facility. A PCB spill reportedly occurred on a portion of a 10 x 10 ft gravel pad.
SS10	KOT-5	Solvent Spill	The site is located at the White Alice Station, approximately 0.5 miles northwest of the Composite Facility. A solvent spill had reportedly occurred covering an approximate 10 x 20 ft area on the edge of a gravel pad.
SS11	KOT-5	Fuel Spill	The site is located at the White Alice Station, approximately 0.5 miles northwest of the Composite Facility. A jet fuel spill reportedly occurred which covered an approximate 50 x 60 ft area.
SS12	KOT-1	Spill No. 2	The site is located west-southwest of the Composite Facility power plant. A diesel fuel spill reportedly occurred in 1979-1980 when the day tank behind the power plant was overfilled.
SS12	KOT-1	Spill No. 3	The site consists of an approximate 1.5 acre area adjacent to, and west-southwest of, the Composite Facility. A large diesel fuel leak reportedly occurred via a hole in a distribution line identified in 1984. The fuel line was repaired, and approximately 4,000 gal of diesel fuel was reportedly collected in recovery trenches subsequently installed by the Air Force.
EXCLUDED SITES			
SS02	KOT-2	Waste Accumulation Area No. 2 /Landfill	The landfill is located on a triangular piece of land adjacent to and north of the former fuel storage tanks on the beach. Waste accumulation Area No. 2 is located northeast of the former fuel storage tanks adjacent (south) to the landfill. The landfill was used until approximately 1974. Waste accumulation Area No. 2 was used until approximately 1972; in 1975, the site was cleaned up and the area graded.
SS06	KOT-1	Spill No. 1	The site is located near the officers wing of Building 103 (northern most wing). A diesel fuel leak reportedly occurred in a fuel line in the mid-1970's due to a coupling failure.

[a] USAF Site Designation to be used as standard format.

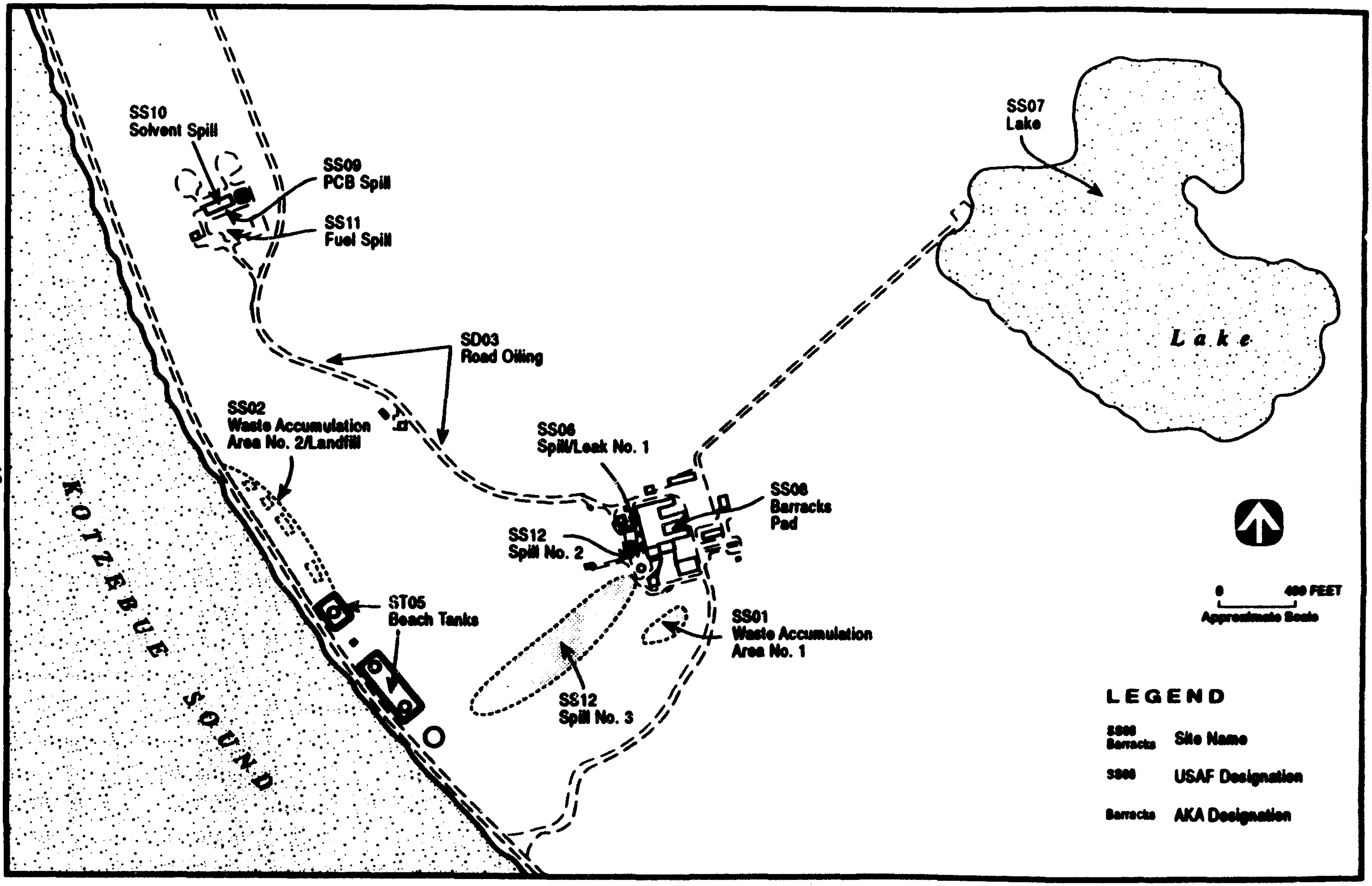

Figure 2-4. Stage 1 RI/FS Site Designation Map, Kotzebue LRRS, Alaska.

Analyses conducted on soil and surface water samples collected during the Stage 1 RI are summarized in Table 2-2. Analytical results indicate that total petroleum hydrocarbons (TPH) constitute the primary soils contamination problem at Kotzebue LRRS. Additionally, polychlorinated biphenyls (PCBs), pesticides, and benzene, ethylbenzene, toluene/xylene (BETX) were detected in soil samples. No organic compounds were detected above laboratory detection limits in a surface water sample collected from the former water supply lake. However, the pesticide 4,4'-DDT (2.6 mg/kg) and the PCB Aroclor 1260 (3.4 mg/kg) were detected in a sediment sample collected from the former water supply lake. Metals concentrations identified in soils and surface waters are reported to be within the typical range for those constituents in the contiguous United States (WCC 1990a). Maximum concentrations of organic compounds and metals identified in site soils and surface waters are provided in Table 2-3 as presented in the Stage 1 RI/FS Final Report.

A soil gas survey was conducted at the SS12-Spills No. 2 and 3 sites to provide a qualitative assessment of the extent of petroleum contamination adjacent to the site. However, the soil gas data are reportedly non-quantifiable, primarily due to the extreme variability of soil moisture content within soils (WCC 1990a). Water-flooding pilot studies were conducted at the SS12-Spill No. 3 site in an attempt to recover free product from contaminated soils. Study results indicate that water-flooding is not a viable remedial alternative; this conclusion was based on inadequate volumes of free-product at the site and the low permeability of site soils (WCC 1990a).

Identified contaminants of concern, including TPH, PCBs, and the organochlorine herbicides/pesticides delta BHC, 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD, were evaluated with respect to state and federal cleanup standards and health and environmental criteria. A qualitative two-tiered health and environmental risk screening approach was developed to identify those sites warranting further consideration regarding remedial actions. Based on the risk screening criteria and methodology used, no Kotzebue LRRS sites reportedly posed significant health or environmental risks (WCC 1990a). Recommended cleanup levels, developed for contaminated soils based on federal criteria and a modified California leaking underground fuel tank (LUFT) manual scoring procedure for TPH, were as follows (WCC 1990a):

TABLE 2-2. SOIL AND SURFACE WATER SAMPLE ANALYTES COLLECTED DURING 1988 STAGE 1 RI/FS

Analyte	Analytical Method	Site Identification
	Soils/Sediment	
Total Petroleum Hydrocarbons	SW3550/E418.1	All 10 sites
Metals Screen by ICP (23 metals, exclude boron & silica)	SW3050/SW6010	SD03-Road Oiling, SS01-Waste Accumulation Area No. 1
Organochlorine Pesticides and PCBs	SW3550/SW8080	All sites except ST05-Beach Tanks
Volatile Organic Compounds	SW8240	All sites except SS09-PCB Spill
Soil Moisture Content	ASTM D-2216	All 10 sites
	Surface Water	
Total Petroleum Hydrocarbons	E418.1	SS07-Lake
Metals Screen (23 metals) by ICP	SW3005/SW6010	SS07-Lake
Purgeable Halocarbons	SW5030/SW8010	SS07-Lake
Purgeable Aromatics	SW5030/SW8020	SS07-Lake
Organochlorine Pesticides and PCBs	SW3510/SW8080	SS07-Lake
Extractable Priority Pollutants	SW3510/SW8270	SS07-Lake

TABLE 2-3. 1988 STAGE 1 RI/FS SUMMARY OF MAXIMUM ORGANIC AND INORGANIC COMPOUND CONCENTRATIONS DETECTED IN SOIL AND SURFACE WATER AT KOTZEBUE LRRS

USAF Site Designations	Media	TPH[a] (mg/kg)	Pesticides (mg/kg)				Organic Compounds and Peak Concentrations (mg/kg)				
			4,4'-DDD	4,4'-DDE	4,4'-DDT	Delta-BHC	PCBs Aroclor 1260	Benzene (mg/kg)	Ethylbenzene (mg/kg)	Toluene (mg/kg)	Total Xylenes (mg/kg)
Maximum Organic Compound Concentrations in Soil[c]											
SS12-Spill No. 2	Soil	10,700	0.027	ND[b]	0.14	ND	ND	ND	1.2	1.0	47
SS12-Spill No. 3	Soil	99,200	2.3	ND	5.7	0.11	ND	0.86	22	28.0	170
SDO3-Road Oil	Soil	97	0.37	ND	ND	ND	ND	ND	ND	ND	ND
SS01-Waste Acc. Area No. 1	Soil	16,200	0.98	ND	ND	ND	ND	ND	ND	ND	ND
SS11-Fuel Spill	Soil	23,100	ND	ND	0.098	ND	ND	ND	ND	5.9	200
SS10-Solvent Spill	Soil	1,460	ND	ND	0.22	ND	25.0	ND	ND	ND	ND
SS09-PCB Spill	Soil	4,600	ND	ND	0.062	ND	32.0	ND	ND	ND	ND
SS08-Barracks	Soil	5,960	0.19	ND	ND	ND	ND	ND	ND	ND	ND
SS07-Lake	Sediment	ND	1.10	0.19	2.6	ND	3.4	ND	ND	ND	ND
	Surface Water	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ST05-Beach Tanks	Soil	5,300	NA	NA	NA	NA	NA	ND	ND	6.2	ND

Maximum Inorganic Compound Concentrations in Soil and Water

	Media	Inorganic Compounds														
		Aluminum	Barium	Beryllium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Sodium	Vanadium	Zinc
SD03 (Road Oil) (mg/kg)	Soil	8,800	170	0.4	3,300	15	8	15	14,200	8	3,400	230	18	50	20	36
SS01 (Waste No. 1) (mg/kg)	Soil	3,800	95	0.1	27,900	13	6	11	13,300	8	12,000	590	29	90	14	120
SS07 (Lake) (mg/L)	Surface Water	ND	0.05	ND	17	ND	ND	ND	10	ND	5.2	0.02	ND	3.3	ND	0.01

[a] TPH = Total petroleum hydrocarbons.
[b] ND = Concentration below detection limit.
[c] Soil contaminant values are reported as "dry weight" results.
[d] NA = Not analyzed.

Contaminant	Concentration (mg/kg)
TPH (ST05-Beach Tanks)	1,000
TPH (All other sites)	10,000
PCBs	10
Benzene	1
Ethylbenzene	50
Toluene	50
Xylene	50

Despite the absence of significant health or environmental risks identified in the risk screening process, WCC (1990a) recommended several sites for further remedial action based on soil analyses indicating contamination above recommended cleanup levels, including the SS12-Spill No. 2, SS12-Spill No. 3, SS01-Waste Accumulation Area No. 1, SS09-PCB Spill, SS10-Solvent Spill, SS11-Fuel Spill, and ST05-Beach Tanks Sites.

WCC conducted an FS to evaluate remedial technologies and identify appropriate remedial alternatives. Four distinct operable units were defined to create a logical division of site contamination problems while providing an appropriate means for remedial assessment. Table 2-4 provides a description of operable units and a summary of remedial alternatives selected by operable unit for sites recommended for further remedial action.

2.1.2.3 Stage 2 RI/FS. In 1989-1990, WCC conducted a Stage 2 RI/FS program at Kotzebue LRRS to address the sites recommended for remedial action based on the findings of the Stage 1 RI/FS. Field activities conducted between July 1989 and September 1990 included pilot-scale remediation tests involving excavation and landfarming, *in situ* enhanced bioremediation, excavation and off-site disposal of PCB contaminated soils, the removal of four transformers, and an investigation of soil and groundwater at the STO5 Beach Tank site.

A landfarm was constructed on a level pad (part concrete and part fill) on the east side of the installation access road, directly east of the Composite Facility. TPH contaminated soils and fill were excavated from the SS01-Waste Accumulation Area No. 1 (approximately 50 yd^3), the SS12-Spill No. 2 (approxi-

TABLE 2-4. OPERABLE UNIT DESCRIPTION AND REMEDIAL ALTERNATIVE SELECTION SUMMARY FOR WCC STAGE 1 AND STAGE 2 RI/FS INVESTIGATIONS

Operable Unit	Operable Unit Description	Remedial Alternatives Selected for Detailed Analysis	Selected Remedial Alternative
Operable Unit A - Soils/Fill Material			
SS12 - Spill No. 2 and 3 SS01 - Waste Accumulation Area No. 1	Sites in this operable unit have been selected based on the nature of the existing soils. Kotzebue LRRS consists of various buildings, roads, and pads to facilitate ovetlain site operations. In these areas, the native tundra has been replaced with fill material, and excavation activities to remove contamination could proceed without further damage to the native tundra.	- Non Action/Institutional Controls - Capping - Excavation/On-Site Thermal Treatment - Excavation/On-Site Landfarming - Excavation/Transportation/Reclamation	- Excavation/On-Site Landfarming
Operable Unit A - Beach Sands and Gravels/Fill			
STO - 5 Beach Tanks	This operable unit includes the beach sands and gravels west of the access road at the ST05 site, as well as fill material that was imported to the site to construct the tank pads (generally beach sands and gravels). Alternatives developed for this operable unit are designed to minimize disruptions to the beach.	- Non Action/Institutional Controls - Excavation/Landfarming - Soil Vapor Extraction - In-Situ Bioremediation (no groundwater recapture)	- In-Situ Bioremediation (no groun dwater recapture)
Operable Unit B - Soils/Native Tundra			
SS12 - Spill No.3 SS11 - Fuel Spill	Sites in this operable unit have an intact tundra ground cover, although part of the site may consist of fill material. Alternatives developed for this operable unit are designed to minimize further disruptions to the tundra.	- Non Action/Institutional Controls - In-Situ Enhanced Biodegradation	- In-Situ Enhanced Biodegradation
Operable Unit C - Soils with PCBs			
SS09 - PCB Spill SS10 - Solvent Spill	Soils containing PCB contamination were identified as a separate operable unit in order to address technologies specific to PCB remediation.	- Non Action/Institutional Controls - Excavation/Off-Site Disposal - In-Situ Enhanced Biogradation	- Excavation/Off-Site Disposal
Operable Unit D - Groundwater			
ST05 - Beach Tanks	This operable unit is the groundwater beneath the beach sands and gravels at the ST05 site.	- Non Action/Institutional Controls - In-Situ Closed Loop Bioremediation - In-Situ Bioremediation (no groundwater recapture)	- In-Situ Bioremediation (no groundwater recapture)

mately 100 yd^3), and the SS12-Spill No. 3 (approximately 350 yd^3) sites, and were stockpiled on 6 mil plastic within the landfarm area. Soils were spread, and emulsification and micronutrient agents were applied. The landfarm was mixed weekly over the course of two field seasons to promote microbial activity, and has been subsequently sampled on an intermittent basis to evaluate TPH reductions.

In situ enhanced bioremediation activities were conducted at the SS12-Spill No. 3 and the SS11-Fuel Spill sites, and included areal applications of emulsifiers and micronutrients. Additionally, treatment infiltration trenches were installed at the SS12-Spill No. 2 Site. Emulsifiers and micronutrients were added to the infiltration trenches in an attempt to degrade TPH in soils surrounding pipes, pumps, tanks, and fencing.

PCB contaminated soils were excavated from two White Alice Sites (SS09-PCB Spill and SS10-Solvent Spill Sites). An estimated 5.3 yd^3 of contaminated soil from Site SS09 and 7.8 yd^3 from Site SS10 were excavated, placed in 55 gallon drums, and shipped to the Defense Reutilization and Marketing Office (DRMO) at Elmendorf AFB. Confirmation soil samples were collected in each excavation to document complete PCB removal.

Soil and groundwater at the ST05-Beach Tanks Site were characterized for the purpose of quantifying the nature and magnitude of contamination, delineating the horizontal and vertical extent of contamination, determining the hydrogeologic setting, and completing an FS of remedial alternatives.

Analyses conducted on soil and groundwater samples collected during the Stage 2 RI/FS are presented in Table 2-5. Analytical results for PCB confirmation soil samples collected from the base and sides of the excavations of the SS09-PCB Spill and SS10-Solvent Spill Sites indicate PCB concentrations below cleanup goals, with maximum residual concentrations of 1.3 mg/kg and 3.7 mg/kg, respectively, for the two sites. Soil samples collected during landfarm and *in situ* enhanced bioremediation activities exhibit a mean reduction in TPH concentrations over time. Table 2-6 presents TPH concentrations measured in samples obtained during the landfarm and *in situ* enhanced bioremediation programs (as presented in the December 1990 Stage 2 RI/FS Report; WCC 1990b). The mean reductions in TPH concentrations observed in landfarm soils over time are probably the result of biological degradation, volatilization, and leaching processes (WCC 1990b). Volatilization was not considered a significant loss mechanism because: 1) volatile components would likely have dissipated from the spill prior to the study; 2) the

TABLE 2-5. SOIL AND GROUNDWATER SAMPLE ANALYTES COLLECTED DURING 1989-1990 STAGE 2 RI/FS

Analyte	Analytical Method	Site Identification
Soils		
Total Petroleum Hydrocarbons	SW3550/E418.1	ST05-Beach Tanks, Landfarm, SS12-Spill No. 3, SS11-Fuel Spill
Polychlorinated Biphenyls	SW3550/SW8080	SS-11 Fuel Spill, SS09-PCB Spill
Semivolatile Organics	SW3550/SW8270	ST05-Beach Tanks
Microbial Enumeration (total, viable, and phenanthrene-specific)	Hobbie et al. 1977	ST05-Beach Tanks, Landfarm
Soil Moisture Content	ASTM D2216	All sites
Permeability	USCOE Manual EM 110-2-1906 App. VII and X (30 Nov. 1970)	ST05-Beach Tanks
Soil Gradation	ASTM D 422-63 (1972)	ST05-Beach Tanks
Groundwater		
Total Petroleum Hydrocarbons	E418.1	ST05-Beach Tanks
Purgeable Aromatics	SW5030/SW8020	ST05-Beach Tanks
Semivolatile Organic Compounds	SW3510/SW8270	ST05-Beach Tanks
Biochemical Oxygen Demand	E 405.1	ST05-Beach Tanks
Chemical Oxygen Demand	E 410.4	ST05-Beach Tanks
Total Dissolved Solids	E 160.1	ST05-Beach Tanks
Microbial Enumeration (total, viable, and phenanthrene-specific)	Hobbie et al. 1977	ST05-Beach Tanks

TABLE 2-6. TOTAL PETROLEUM HYDROCARBON CONCENTRATIONS IN SOIL SAMPLES COLLECTED FROM THE LANDFARM, NATIVE TUNDRA, AND DISTURBED TUNDRA, KOTZEBUE LRRS, AUGUST-SEPTEMBER 1989 AND JULY-SEPTEMBER 1990.

Sampling Date	Number of Samples	Mean Concentration (mg/kg)	Standard Deviation	Standard Error
LANDFARM SITE				
August 8, 1989	9	9,656	3,946	1,315
September 12, 1989	9	5,237	1,385	462
September 26, 1989	9	5,919	2,602	867
July 25, 1990	10	4,044	567	179
September 24, 1990	10	2,359	551	174
NATIVE TUNDRA (SS12-Spill No. 3 Site)				
August 8, 1989	5 4[a]	6,018 7,500	5,513 5,088	2,465 2,544
September 12, 1989	5	5,338	7,363	3,293
September 26, 1989	5	5,338	7,363	625
July 24, 1990	10	3,118	2,199	695
September 24, 1990	10 9[b]	2,044 1,306	2,604 1,230	824 410
DISTURBED TUNDRA (SS11-Fuel Spill Site)				
August 8, 1989	5	6,310	1,709	764
September 12, 1989	5	1,597	1,533	686
September 26, 1989	5	726	608	272
July 25, 1990	10	1,013	469	148
September 24, 1990	10	575	603	191

[a] If one analysis of 90 mg/kg is removed as an apparent outlier.

[b] If one analysis of 8,680 mg/kg is removed as an apparent outlier.

Note: This table was adapted from the Woodward-Clyde Consultants December 1990 Draft Stage 2 RI/FS Report.

volatile components of arctic diesel fuel represent approximately 30 percent (by weight) of the total mixture; 3) relatively cold temperatures and high soil moisture contents were noted during the study; 4) insufficient aromatic hydrocarbon detections were obtained during the initial site investigation (WCC 1990b). Leaching was also reportedly not an important loss mechanism because: 1) construction of a berm around landfarm reduced surface run-off potential; 2) a majority of organic components in diesel fuel are hydrophobic; 3) soils were subject to many years of precipitation and leaching prior to study (WCC 1990b).

The mean reduction in TPH concentrations observed in the disturbed tundra treatment area (SS11-Fuel Spill Site) is partially attributable to dilution resulting from the mixing of approximately 24 yd^3 of clean beach soil, which was added to reduce the soil moisture content (WCC 1990b). The mean reduction in TPH concentrations observed in native tundra (SS12-Spill No. 3 Site) must be viewed with caution due to the limited number of soil locations sampled and the uneven distribution of TPH across the tundra hill site (WCC 1990b). The degree to which natural degradation of diesel fuel contamination has occurred in native tundra has not been evaluated. However, the reported revegetation of the hillslope is a potential indication of TPH reduction (WCC 1990b). TPH concentrations identified in soil and groundwater samples from the STO5-Beach Tanks Site ranged from 70 to 21,000 mg/kg (soils) and 560 to 8,700 mg/L (groundwater). In addition to contaminant chemistry, conventional and biological characterization of groundwater adjacent to the beach tanks was conducted as part of the feasibility study. Table 2-7 presents maximum detected concentrations in STO5-Beach Tanks Site soil and groundwater samples.

Diesel fuel from surface storage tanks was the primary contaminant at the STO5-Beach Tanks Site based on detections of TPH in soils and groundwater. Applicable or relevant and appropriate requirements (ARARs) were evaluated by WCC. Federal and State regulations that would potentially serve as ARARs were identified. Based on modified LUFT criteria, WCC recommended a TPH cleanup level of 1,000 mg/kg for beach soils. Chemical substances identified in soil and groundwater samples from the site include 2-methylnaphthalene, toluene, total xylenes, ethylbenzene, and TPH (see Table 2-7). A qualitative two-tiered risk screening methodology developed during the Stage 1 RI/FS was used to establish potential health and environmental risks at the site. The overall conclusion reported by WCC states that TPH at the beach tank site presents a potentially significant risk to aquatic organisms (WCC 1990b).

TABLE 2-7. 1989-1990 STAGE 2 RI/FS MAXIMUM DETECTED CONCENTRATIONS IN ST05-BEACH TANKS SITE SOIL AND GROUNDWATER SAMPLES		
Analytes	Soils (mg/kg)	Groundwater (mg/L)
TPH	21,000	8,700
Ethylbenzene	NA[a]	0.0063
Toluene	NA	0.034
Xylenes	NA	0.140
2-Methylnaphthalene	26	NA
Dissolved oxygen	NA	16
Chemical oxygen demand	NA	526
Biological oxygen demand	NA	81
Total dissolved solids	NA	1,250
Microbial Enumeration[b]		
Total bacteria	NA	5.73
Colony forming	NA	1.30
Fluorescent pseudomonad	NA	8.0
Phenaphthrene degraders	NA	1.03

[a] NA = Not analyzed.

[b] Total bacteria (x 10^7 per mL)
Colony forming units (x 10^7 per mL)
Fluoresent pseudomonads (x 10^1 per mL)
Phenaphthrene degraders (x 10^6 per mL).

A feasibility study (FS) was conducted by WCC for the ST05-Beach Tanks Site, identifying remedial technologies and evaluating technical applicability using site characteristics and data collected during the RI. Two operable units were developed for the beach area to provide appropriate remedial alternative evaluation. Remedial alternatives selectively screened and selected by operable unit for the ST05-Beach Tanks Site is presented in Table 2-4. An Interim Remedial Measure (IRM) was recommended by WCC for source control of fuel remaining in the beach tanks. The recommended IRM was to pump remaining fuels through a gravity water separator and use fuels locally as heating fuel.

Based on Stage 2 RI/FS results, the following sites were recommended for follow-on actions at Kotzebue LRRS (WCC 1990b):

- SS12-Spill No. 2 Site -- Continue the pilot study at the landfarm. Implement remedial actions at active pipelines, tanks, roadways, and the security fence.

- SS12-Spill No. 3 Site -- Continue the pilot study at the landfarm, and continue the *in situ* enhanced bioremediation pilot study on the tundra.

- SS11-Fuel Spill Site -- Continue the *in situ* enhanced bioremediation pilot study.

- ST05-Beach Tanks Site -- Mitigate soil and groundwater contamination using *in situ* bioremediation without groundwater capture.

Kotzebue LRRS Stage 2 RI/FS sites recommended for no further action included the SS01-Waste Accumulation Area No. 1, SS09-PCB Spill, and SS10 Solvent Spill Sites (WCC 1990b).

2.1.2.4 Beach Tanks Removal. Three diesel fuel storage tanks were formerly located approximately 0.25 miles southwest of the installation's Composite Facility, adjacent to Kotzebue Sound (see Figure 2-4). Two of the storage tanks were 50 ft in diameter and 22 ft high, each with a capacity of 7,890 barrels. The third storage tank measured 44 ft in diameter and 24 ft high, with a capacity of 6500 barrels (WCC 1990b). The estimate made during WCC RI/FS activities of the cumulative diesel fuel remaining in the three storage tanks was approximately 39,500 gal. In 1992, the Air Force removed the three diesel fuel storage tanks from the site. Only the tank nests (bermed containment areas), asphalt tank pads within bermed areas, and the fuel pump house remain at the site.

2.1.2.5 Environmental Baseline Survey (Navigational Aid Bldg. 101). In July 1993, Shannon and Wilson, Inc. conducted an environmental baseline survey of the Kotzebue LRRS Navigational Aid Building (Bldg. 101; see Figure 2-3). The environmental baseline survey was conducted for the University of Alaska, Fairbanks Facility Planning and Project Services Department as a requirement for a USAF long-term lease for this facility. The environmental baseline survey included the collection of eight building material samples for asbestos and four hand-augered soil samples for diesel range TPH analysis.

Asbestos building materials were identified in siding panels on the exterior walls and floor, and in the interior wall wainscoting (Shannon and Wilson, Inc. 1993). Analytical results for diesel-range TPH in soils is provided below.

Sample Identification	Sample Location	Diesel-Range TPH (mg/kg)
577-10	East side of above-ground storage tank north of building	4,200
577-11	East side of generator tank stand, south of building	700
577-12	8 feet east of above-ground storage tank, 7 feet north of building	180
577-13	In tundra approximately 110 feet north, and 25 feet west of west edge of building	70

Fuel was reportedly supplied to a generator and diesel furnace via above-grade steel pipelines connecting two small-capacity above-ground tanks. Spillage or overflow from the fuel delivery system reportedly resulted in soil contamination in the immediate vicinity of the tanks, and may be present at locations along the pipeline corridor (Shannon and Wilson, Inc. 1993).

2.1.2.6 1993 Site Survey. On 29 September 1993, Tetra Tech and Air Force personnel and their contractors conducted a site survey of Kotzebue LRRS and surrounding areas. The site survey was conducted to evaluate current site conditions, identify potential areas of concern, and obtain the information necessary to prepare RI/FS scoping documents in preparation for the 1994 IRP field activities. Based on the 1993 Site Survey, and discussions between Tetra Tech and Air Force personnel, ten areas of concern were identified for consideration in addition to the sites previously identified in the Stage 1 RI/FS Report (WCC 1990a). Identification and description of areas of concern is provided in Table 2-8. Figure 2-5 provides an installation diagram identifying the location of areas of concern.

The former landfill and waste accumulation area located adjacent to Kotzebue Sound were inspected during the site survey. The former landfill area exhibits intermittent areas of mounding that contain landfill debris, including metal wastes such as drums and other empty metal containers and metal debris. Additionally, two 12 volt batteries were identified mixed with metal debris at one mounded location. In the WCC Stage 1 RI/FS report (WCC 1990a), it was indicated that some former landfill wastes remained buried at the site. However, the site was excluded during the Stage 1 remedial investigation, and was recommended for no further action. The buried landfill wastes described by WCC are suspected to comprise the mounding observed during the 1993 Site Survey.

The landfarm located east of the Composite Facility was also inspected during the site survey. Based on visual inspection, the landfarm has not been properly maintained, with no cover to prevent infiltration or runoff and no limitations to site access. Landfarm soils were manually exposed during the site survey, revealing visual and olfactory indications of petroleum hydrocarbon contamination. Additionally, the formerly bermed margin of the landfarm was not discernable from the landfarm material proper. The landfarm has been included as an area of concern (see Table 2-8).

The SS12-Spills No. 2 and 3 Site was inspected during the site survey. In general, previous descriptions of this area reflect the observed site conditions, and include zones of stressed vegetation and petroleum hydrocarbon seepage from a small area of sloping gravel fill material. During previous IRP investigations, the excavation of soils was conducted to remove source materials. However, the specific excavation zones were not discernable, possibly due to regrading activities.

TABLE 2-8. 1993 SITE SURVEY AREAS OF CONCERN

Site Designation	Site Name	Site Description
AOC-1	Landfarm	During the Stage 2 RI/FS approximately 500 yd^3 of TPH contaminated soils were excavated from Spills No. 2 & 3 and Waste Accumulation Area No. 1 sites and stockpiled east of the access road, directly across from the Composite Facility. Landfarm activities were conducted to reduce TPH concentrations in affected soil throughout the Stage 2 RI/FS. During the 1993 site survey the landfarm was observed to be in poor condition, with no cover to reduce seasonal infiltration and runoff.
AOC-2	POL Line	Previous investigations at Kotzebue LRRS have not included assessment of the fuel line that transferred fuel from the POL (diesel) fuel tanks, formerly located on the beach, to the main facility.
AOC-3	East Tanks	Two above-ground diesel fuel storage tanks, with an estimated capacity of 20,000 gal each, are located on the east side of the access road adjacent to Building 205. The tanks are supported on concrete footings set in a gravel pad, and are contained within a bermed area. The tanks and surrounding area have not been previously assessed, and some limited signs of soil staining directly beneath outlet valves was observed during the 1993 site survey.
AOC-4	Garage/ Power Plant	Stained soils were observed beneath the raised flooring (approx. 4 ft above ground surface) of the power plant and garage area associated with the Composite Facility. It has not been established that floor drains within these areas discharged directly to the ground.
AOC-5	Small Day Tanks	A number of small day tanks (250 gal above ground diesel fuel tanks) were formerly used throughout the installation. Potential diesel fuel releases could have occurred historically due to overfilling or direct release from tanks or tank lines. No previous assessment of these smaller tanks (as a group) has been conducted.
AOC-6	Navigational Aid Bldg. (101-200)	The navigational aid building is located north of the Composite Facility. The navigation aid building and an adjacent associated structure have been included for assessment based on elevated TPH in soils identified during a 1993 environmental site assessment conducted at Building 101. During the 1993 site survey the buildings were locked and not accessible. The surrounding area did not indicate obvious signs of contamination.
AOC-7	Steel Pilings	This site is identified by steel structure pilings (I-Beams) located east of Building 205, on the east side of the installation's access road. Buildings identified during review of historical aerial photographs suggest that this area was a former construction camp site established during initial radar facility construction.
AOC-8	White Alice Garage	The White Alice garage was reportedly used for storing and servicing site vehicles; no identified releases or hazardous materials storage information has been reported. However, this area has not been previously characterized, and has been recommended for assessment based on past usage of the building. During the 1993 site inspection the building was not accessable for interior inspection. Based on visual observations reported, no obvious signs of contamination were identified.
AOC-9	White Alice Tanks	Two diesel fuel storage tanks, with an estimated capacity of 20,000 gal each, are located at the White Alice Station adjacent to Building 1001. The tanks are presently empty, and tank piping has been disconnected. The tanks are contained within a bermed area and are supported above a gravel base by concrete footings. The tanks are a new area of concern based on reports regarding observed overfilling at outlet valves during previous 11th CEOS site visits. The 1993 site survey revealed some signs of soil staining directly beneath outlet valves, and an open drum under one of the tank valves was half filled with water, and is assumed to have been used to contain fuel spillage during piping disconnection. The tanks appear to be in good condition, with no observable signs of deterioration.
AOC-10	Septic Holding Tank	The primary sewage treatment of domestic wastewater was provided by a single septic tank located west of the composite facility. Septic tank effluent was discharged into Kotzebue Sound through an outfall line. Shop floor drain wastewater was reportedly discharged to septic tank.

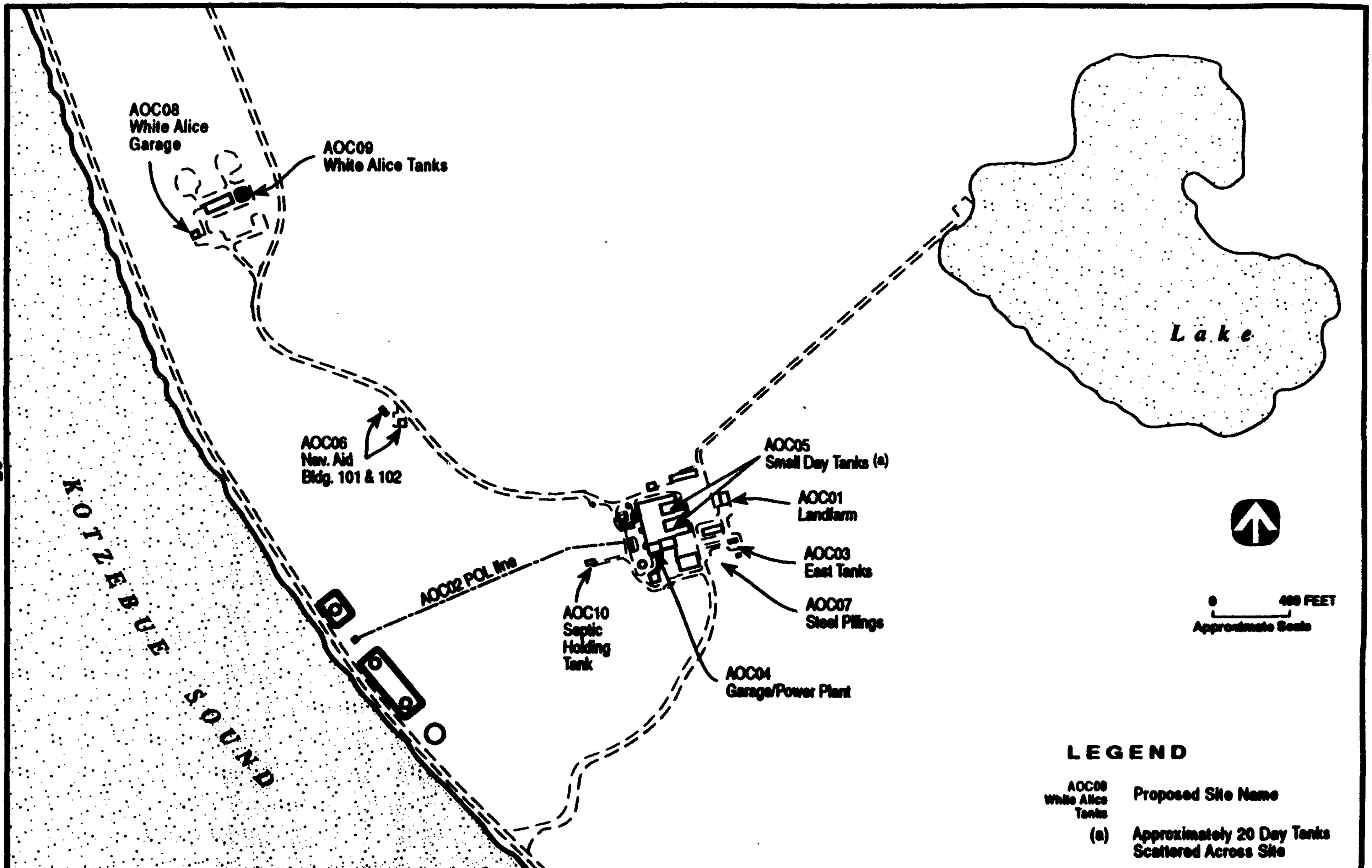

Figure 2-5. Areas of Concern (AOCS) Identified During 1993 Site Reconnaisance, Kotzebue LRRS Alaska.

2.2 PROJECT SCOPE AND OBJECTIVES

Tetra Tech's general approach regarding the development of the Kotzebue IRP RI/FS is to maximize the use of existing data from previous investigations. Available site information has been integrated into the Kotzebue LRRS site conceptual model, and has been used to identify additional data needs, facilitate the selection of remedial designs, and to guide the risk assessment process. Overall project objectives for the Kotzebue LRRS RI/FS include:

- Provide data of sufficient quality and quantity to adequately characterize sites in support of a natural biodegradation evaluation, baseline risk assessment, applicable or relevant and appropriate requirements (ARARs), and a feasibility study.

- Conduct a feasibility study designed to enable the USAF to focus on appropriate remedial actions with consideration to logistical, environmental condition, and climatic limitations.

- Provide appropriate project information and opportunities for community involvement in order to develop a positive relationship between the USAF and the community of Kotzebue, Alaska.

2.2.1 Field Activities Summary

The field investigation activities described in the following sections are proposed to meet project and site objectives, and are based on a review of past IRP investigation activities, site survey information, a background literature search, and the development of the Kotzebue LRRS site conceptual model. All field investigation activities and methodology will conform to the guidelines established by the *Handbook*.

Six sites identified during previous IRP field investigations have been selected for further characterization. The sites were selected based on a review of historical site information, previous IRP RI/FS results, ADEC correspondence concerning current site conditions, and site survey information. The six sites include: 1) Site SS02-Waste Accumulation Area No.2/Landfill; 2) Site ST05-Beach Tanks; 3) Site SS07-Lake; 4) Site SS08-Barracks Pad; 5) Site SS11-Fuel Spill; and 6) Site SS12-Spills No. 2 and 3. During September 1993, Tetra Tech and Air Force personnel conducted a site survey of the Kotzebue LRRS and surrounding areas. Ten areas of concern (AOCs) were identified during the site survey that warrant further consideration during this RI/FS field sampling effort. Figure 2-6 identifies sites and areas of concern (AOCs) to be investigated at Kotzebue LRRS. A summary of proposed field activities for Kotzebue LRRS is provided in Table 2-9.

2.2.2 Intended Use of Data

Data needs for Kotzebue LRRS include both screening-level measurements and data of sufficient quality to be used in the health and ecological risk assessment, in the feasibility study, and to ensure compliance with ARARs. In addition, sufficient information must be provided to meet the requirements of the IRPIMS database.

For data collected during the work effort at Kotzebue LRRS, the main analytical program will be performed at a fixed base laboratory at Analytical Support Level III, with rigorous documentation performed according to requirements specified in the *Handbook*. The field screening analyses included in the geophysical and tidal surveys will be conducted according to Level II protocols. Site-specific health and safety screening, measurement of parameters during environmental sample collection, and measurements associated with well development and purging will be conducted according to Level 1 protocols. The quality criteria employed for the Kotzebue LRRS RI/FS address the following data characteristics: accuracy, precision, completeness, representativeness, and comparability. Project data quality objectives and a quality criteria assessment for the Kotzebue LRRS RI/FS are presented in detail in following sections 4.0, Quality Assurance Objectives for Measurement Data.

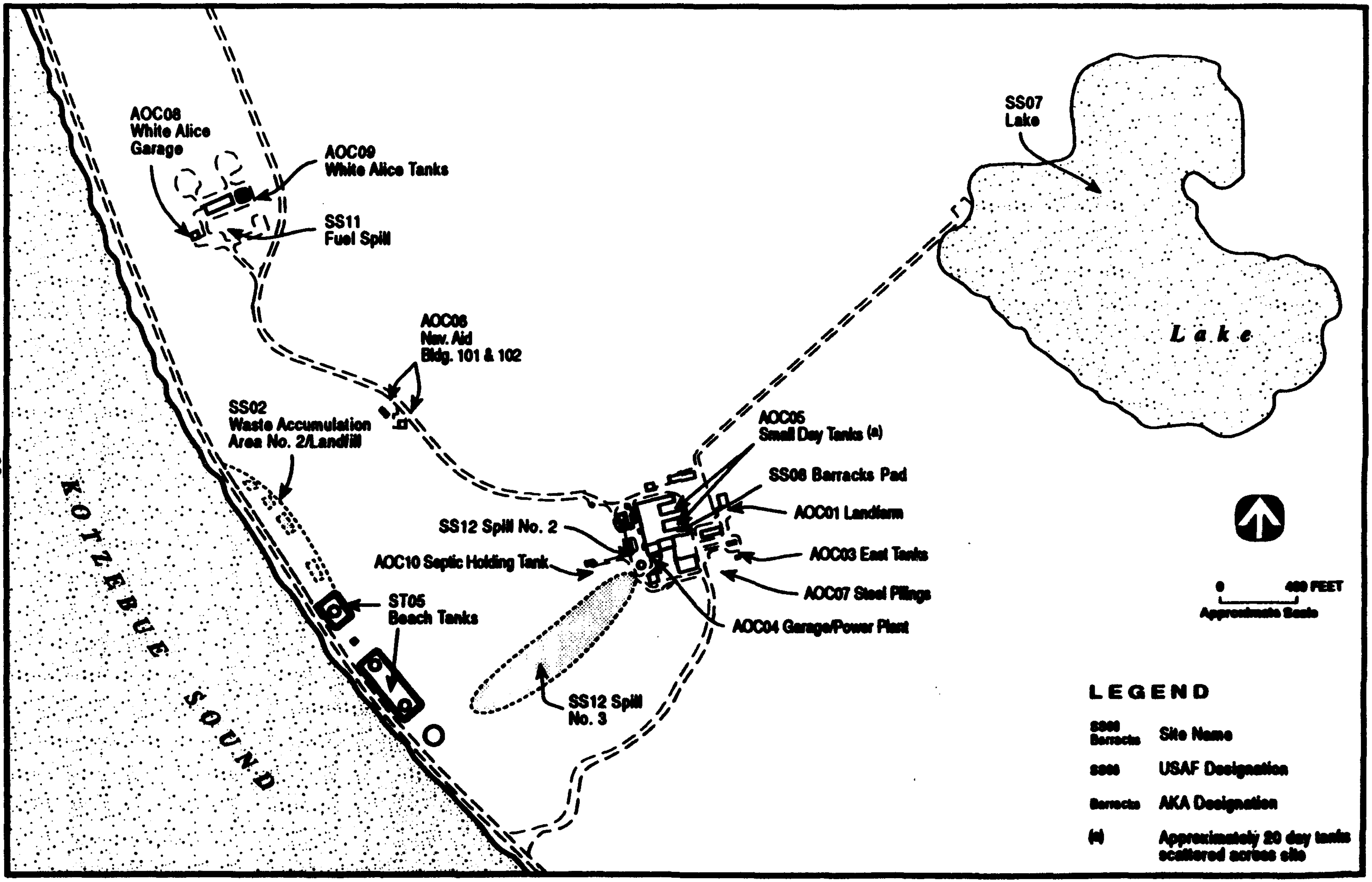

Figure 2-6. Areas of Investigation, Kotzebue LRRS, Alaska.

TABLE 2-9. SUMMARY OF PROPOSED FIELD ACTIVITIES FOR KOTZEBUE LRRS, ALASKA

Site Designation	Facilities Inspection	Field Screening	Hand Auger Sampling	Drilling and Sampling	Installing Wells	Groundwater Sampling	Surface Water Sampling	Seawater Sampling	Free Product Assessment	Influence	Aquifer Testing	Geotechnical Parameters	Gradiometer Survey	Sample Location Surveying
SS02-Waste Area No. 2/Landfill		X		X	X	X							X	X
ST05-Beach Tanks		X		X	X	X		X	X	X	X	X		X
SS07-Lake		X	X				X							X
SS08-Barracks Pad		X	X									X		X
SS11-Fuel Spill		X	X									X		X
SS12-Spills No. 2 and 3		X	X	X	X	X	X		X			X		X
AOC-1 Landfarm Landfarm Seeps		X X	X X											X X
AOC-2 POL Lines		X	X											X
AOC-3 East Tanks		X	X											X
AOC-4 Power Plant Garage	X	X	X											X
AOC-5 Small Day Tanks		X	X											X
AOC-6 Nav. Aid Bldg.	X	X	X											X
AOC-7 Steel Pilings	X	X	X											X
AOC-8 White Alice Garage	X	X	X											X
AOC-9 White Alice Tanks		X	X											X
AOC-10 Septic Holding Tank	X	X												X
Background Characterization		X	X	X	X	X	X	X						X

2.3 IDENTIFICATION OF ANALYTICAL LABORATORIES, SUBCONTRACTORS, AND THEIR TASKS

The following subcontractors will provide services for work accomplished under the IRP RI/FS at Kotzebue LRRS:

Analytical Laboratory

Primary Source:

Analytical Resources, Inc.
333 9th Avenue, North
Seattle, WA 98109
Telephone (206) 621-6490
Facsimile (206) 621-7523

Auxiliary Sources:

PACE Inc. - Minnesota Regional Laboratory
1710 Douglas Drive North
Minneapolis, Minnesota 55422
Telephone (612) 544-5543
Facsimile (612) 525-3377

When auxiliary laboratories have been selected to serve as a backup to the primary lab, all relevant QA/QC elements are detailed into a laboratory specific addendum to the QAPP. This will also be true of any laboratory required for specialty analyses identified during the RI/FS process. These auxiliary laboratories will comply with the format of this QAPP and the *Handbook*, where relevant. All QC criteria, calibration procedures, and other requirements stated in the QAPP will be described for any other analytical laboratory in compliance with the QAPP. This supplemental information will be submitted for review to relevant agencies and the Kotzebue LRRS Restoration Team Chief prior to implementation.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The organization, functional responsibilities of key staff, levels of authority among key participants, and lines of communications for activities affecting the QAPP for this project are presented on Figure 3-1 and discussed in the following sections.

3.1 PROJECT PERSONNEL

The project personnel have been selected to provide the specific technical and management capabilities and qualifications as required. Mr. Michael McGhee is the Restoration Team Chief (RTC) and Contracting Officer's Representative (COR) for the RI/FS activities associated with the IRP site at Kotzebue LRRS (see Figure 3-1).

3.1.1 Project Managers

The Project Manager for the Kotzebue LRRS work effort is Mr. Roderick A. Carr. Mr. Carr is responsible for overall direction, coordination, and technical consistency of the Kotzebue LRRS project efforts (see Figure 3-1).

3.1.2 Program QA/QC Director

Dr. William Brownlie is designated as the IRP Program QA/QC Director. He remains independent of the cost, scheduling, and other performance constraints that are the responsibilities of the Task or Subtask Managers (see Figure 3-1). Dr. Brownlie also serves as the overall IRP Program Manager for Tetra Tech, Inc.

3.1.3 Project QA/QC Manager

Dr. Garabed Kassakhian is the Project QA/QC Manager (see Figure 3-1). Dr. Kassakhian will be responsible for all project-related QA/QC elements. These include both laboratory and field activities associated

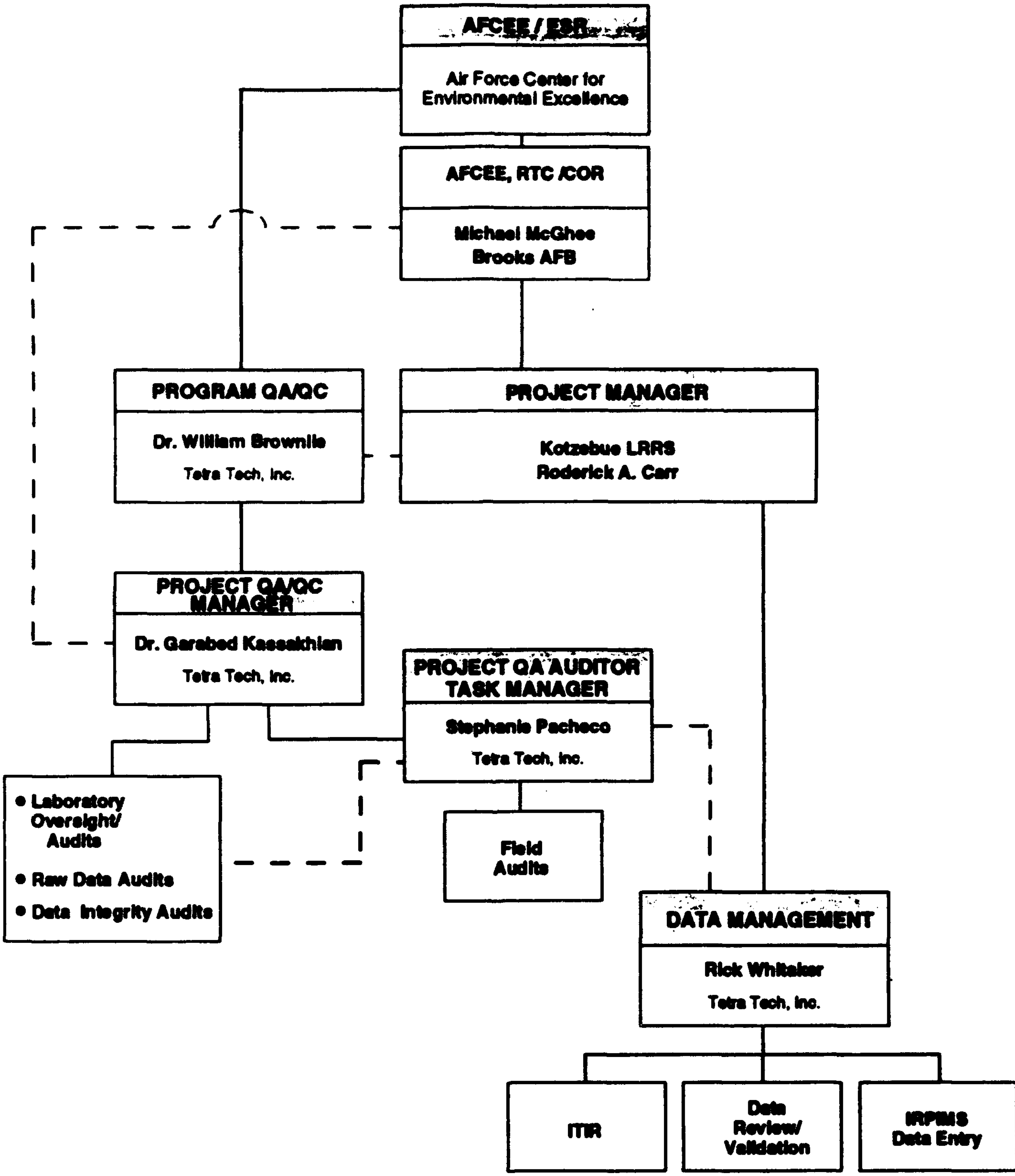

Figure 3-1 Kotzebue LRRS Program QA/QC Organization

with the RI/FS investigation at Kotzebue LRRS. He will review deliverables containing reviewed or validated data such as the Analytical Informal Technical Information Reports (ITIR), or the Installation Restoration Program Information Management System (IRPIMS) disk deliverable. Dr. Kassakhian will also review final laboratory and field audit reports and any relevant Standard Operation Procedures (SOPs) provided to him by the laboratory Data Management Project Manager and other personnel (see Figure 3-1). He will organize and supervise the onsite laboratory audit, raw data and data integrity audits.

3.1.4 QA Auditor

Ms. Stephanie Pacheco is the Project QA Auditor (see Figure 3-1). Ms. Pacheco or her designee will be responsible for initiating audits of both laboratory and field activities. Once any audit is complete, a report on the status of the QA/QC of the system under analysis will be completed and given to both the Project QA/QC Manager and the Project Manager for review and possible action. She will also provide oversight and direction to the Data Management Project Manager. Once ITIR and IRPIMS deliverables are completed, she will audit these documents prior to review by the Project QA/QC Manager.

3.1.5 Data Management

Mr. Rick Whitaker, a California registered geologist (RG #4368) is the Data Management Project Manager and will be responsible for all deliverables associated with the Kotzebue LRRS RI/FS Program. He will be responsible for the production of the Informal Technical Information Report (ITIR) that will include reviewed or validated data. He will also be responsible for the Installation Restoration Program Information Management System (IRPIMS) deliverables for the Kotzebue LRRS RI/FS (Figure 3-1).

3.2 ANALYTICAL RESOURCES, INC.

At ARI, the President is Mr. Mark Weidner. Mr. Weidner communicates directly with the QA Officer as well as her staff and also with the specific managers of the various sections associated with the laboratory (Figure 3-2).

Ms. Michelle Turner is the QA Officer of ARI and Ms. Suzanne Kitch provides QA/QC support to her (Figure 3-2). Their responsibilities include preparation of written documents defining QA/QC procedure,

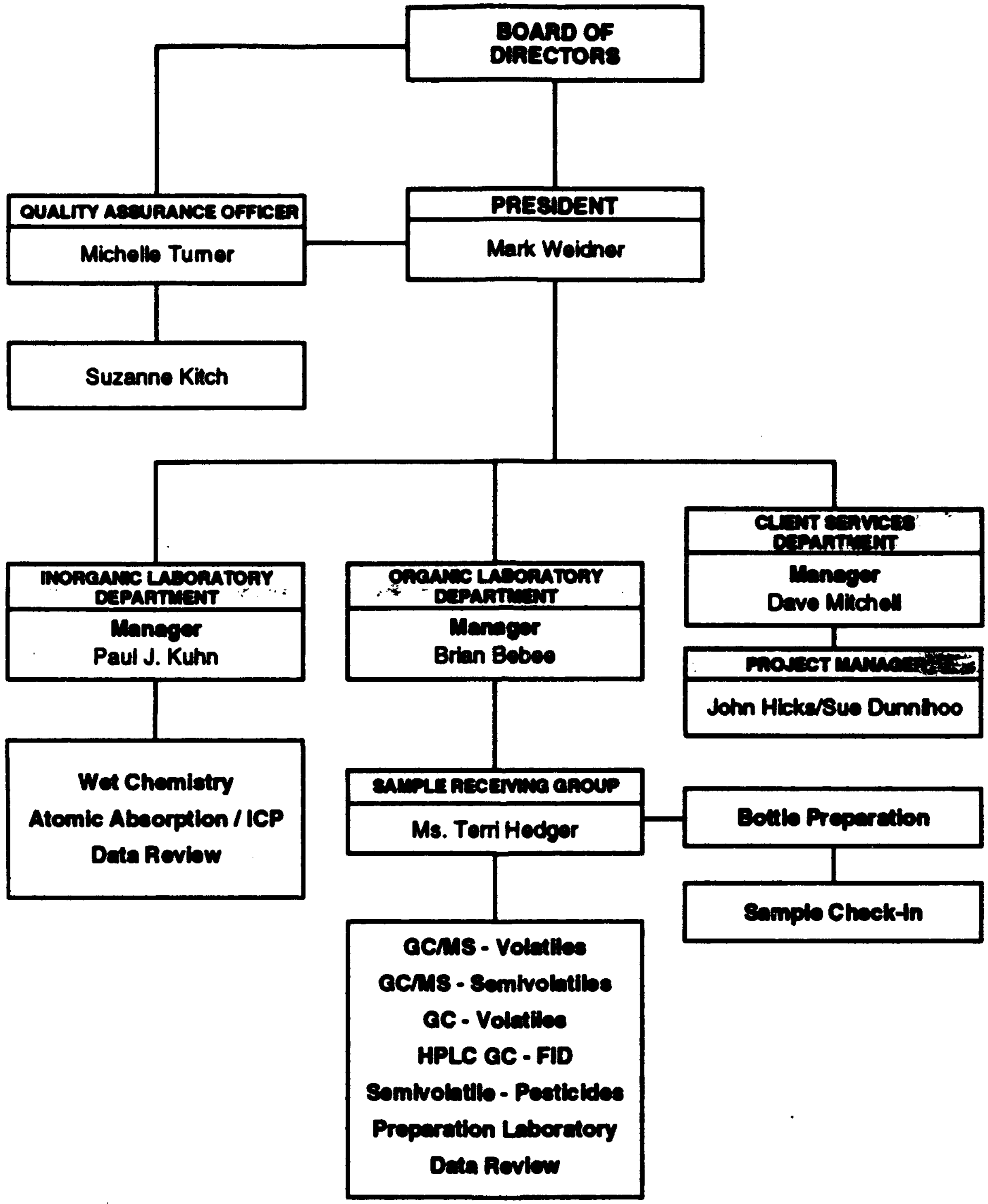

Figure 3-2 Organization of Analytical Resources, Inc.

as well as review and approval of laboratory QC procedures, supervision of sample control operations, and oversight of intra-laboratory testing programs and certifications. Mr. John Hicks and Ms. Sue Dunnihoo are the ARI Project Managers for the RI/FS work effort at Kotzebue LRRS (see Figure 3-2). Mr. Hicks and Ms. Dunnihoo provide contact between ARI and Tetra Tech, Inc. on issues such as technical questions regarding analytical results, scheduling and shipping, sample containers, and other issues that are not QA questions.

Data associated with environmental samples collected during the RI/FS work effort at the Kotzebue LRRS will be constantly checked by ARI staff at all levels to ensure that appropriate QC measures have been taken and the outcomes are within acceptable ranges. The effectiveness of the ARI laboratory QA/QC program is continuously evaluated by the QA/QC staff. Data that fails prescribed criteria will be reported to the ARI QA/QC staff. Once evaluated, a QC staff member or the Project Manager will notify Mr. R. Carr, Project Manager, and/or Dr. Kassakhian, Project QA/QC Manager, Tetra Tech, Inc. immediately by telephone with a written follow-up to be sent by mail.

Mr. Paul J. Kuhn is the manager of the Inorganic Laboratory Department of ARI while Mr. Brian Bebee is the Manager of the Organic Laboratory Department. The various methods and functions for those departments are detailed in Figure 3-2.

Bottle preparation and sample check-in are directed by the Sample Receiving Group under the guidance of Ms. Terrie Hedger (see Figure 3-2).

4.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

Data quality objectives (DQOs) are qualitative and quantitative statements developed by data users to specify the quality of data from field and laboratory data collection activities to support specific decisions or regulatory actions. The DQOs describe what data are needed, why the data are needed, and how the data will be used to address the problem under investigation. DQOs also establish numeric limits for the data to allow the data user (or reviewers) to determine whether data collected are of sufficient quality for use in their intended application.

Data needs for Kotzebue LRRS include both screening measurements and data of sufficient quality to be used in the health and ecological risk assessment and in the feasibility study. In addition, sufficient information must be provided to meet the requirements of the IRPIMS database.

The EPA has established a hierarchy of DQOs which are qualitative and quantitative statements that specify the quality of data required to support regulatory decisions during remedial response. For data collection during the work effort at Kotzebue LRRS, main analytical program will be performed at a fixed base laboratory at Level III, with rigorous documentation performed according to the *Handbook* Level I data reporting requirements. The field screening analyses included in the soil gas and geophysical surveys will require Level II protocol. Site-specific health and safety screening and measurement of parameters during environmental sample collection and well development and purging will be at Level I protocol. Table 4-1 provides a summary of analytical levels appropriate to data uses during the work effort at Kotzebue LRRS.

Quality criteria to be employed at Kotzebue LRRS address the following data characteristics: accuracy, precision, completeness, representativeness, and comparability. These criteria are discussed below.

TABLE 4-1. SUMMARY OF EPA'S ANALYTICAL LEVELS APPROPRIATE TO DATA USES AT KOTZEBUE LRRS, ALASKA

Data Uses	Analytical Level	Type of Analysis	Limitations	Data Quality Objective
Site Characterization; Monitoring During Implementation	Level I	Total organic/inorganic vapor detection using portable instruments, field determination of pH, conductivity Field test kits	Instruments respond to naturally occurring compounds	If instruments are calibrated and data are interpreted correctly, can provide indication of contamination
Site Characterization; Evaluation of Alternatives; Engineering Design; Monitoring During Implementation	Level II	Variety of organics by gas chromatography during soil gas survey, geophysical survey to determine depth to bedrock; buried landfill materials; point counting of asbestos fibers using plane polarized microscopy Detection limits vary from low parts per million to low parts per billion.	Tentative identification	Dependent on QA/QC steps employed
Risk Assessment; Potentially Responsible Party Determination; Site Characterization; Evaluation of Alternatives; Engineering Design; Monitoring During Implementation	Level III	Organics/inorganics using EPA or U.S. Army Environmental Center procedures other than CLP; can be analyte specific	Tentative identification in some cases	Similar detection limits to CLP
		RCRA characteristics tests	Can provide data of same quality as Level IV	Less rigorous QA/QC
Risk Assessment; Potentially Responsible Party Determination; Evaluation of Alternatives; Engineering Design	Level IV	Hazardous Substance List, CLP, organics/inorganics by gas chromatography/mass spectroscopy; atomic absorption; inductively coupled plasma	Tentative identification of non-hazardous substance list parameters	Goal is data of known quality
Risk Assessment; Potentially Responsible Party Determination	Level V	Low parts per billion detection limit	Some time may be required for validation of packages	Rigorous QA/QC
		Nonconventional parameters	May require method development/modification	Method-specific
		Method-specific detection limits	Mechanism to obtain services requires special lead time	
		Modification of existing methods		

Source: Environmental Protection Agency 1987.

4.1 DEFINITION OF CRITERIA

4.1.1 Accuracy

Accuracy is the degree of agreement of a measurement or average of measurements with an accepted reference or "true" value, and is a measure of bias in the system.

4.1.2 Precision

Precision is a measure of mutual agreement among individual measurements of the same property under prescribed similar conditions.

4.1.3 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected under correct, normal conditions.

4.1.4 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

4.1.5 Comparability

Comparability expresses the confidence with which one data set can be compared to another data set measuring the same property. Comparability is ensured through the use of established and approved sample collection techniques and analytical methods, consistency in the basis of analytes (wet weight, volume, etc.), consistency in reporting units, and analysis of standard reference materials.

4.2 MEASUREMENT OF DATA QUALITY

4.2.1 Accuracy

For this project, accuracy of the measurement data will be assessed and controlled. Field instruments have a potential accuracy which is specified by the manufacturer. The ability to obtain this level of accuracy depends on proper calibration. For the laboratory, results of method blank analysis, as well as reagent, matrix, and surrogate QC sample results, will be the primary indicators of accuracy. These results will be used to control accuracy within acceptable limits by requiring that they meet specific criteria. As these spiked QC samples are analyzed, spike recoveries will be calculated and compared to pre-established laboratory acceptance limits. The calculation formula for percent recovery is:

$$\%\ Spike\ Recovery = \left(\frac{[Value\ of\ Sample\ Plus\ Spike\ Added] - [Value\ of\ Unspiked\ Sample]}{[Value\ of\ Spike\ Added]}\right) X\ 100 \quad [1]$$

Acceptance criteria, also termed "control limits," will be based on previously established (i.e., historical) laboratory capabilities for similar samples using control chart techniques. In this approach, the control limits reflect the minimum and maximum recoveries expected for individual measurements for an in-control system. Recoveries outside the established control limits indicate some assignable cause, other than normal measurement error, and the possible need for corrective action. Corrective action could include recalibration of the instrument, reanalysis of the QC sample, reanalysis of the samples in the batch, or flagging the data as suspect if the problem cannot be resolved. These results will be reported to the Tetra Tech, Inc. Project QA/QC Manager.

According to the *Handbook* resampling may be performed if samples exceed their specific holding time requirements or are not preserved properly. If second column analysis, where appropriate, is not performed within the specified holding time, resampling may be undertaken.

4.2.2 Precision

Precision is defined as a measure of mutual agreement of a measurement or average of measurements with an accepted reference of "true" value. Based on these results, a measure of bias within the system can be estimated. Precision of the measurement data gathered during the work effort at Kotzebue LRRS will be based on QC sample analyses (repeatability), replicate analyses (replicability), and results obtained from duplicate/replicate field samples (sample replicability).

Precision is independent of the error (accuracy) of the analyses and reflects only the degree to which the measurements agree with one another, not the degree to which they agree with the "true" value for the parameter measured. Precision is calculated in terms of Relative Percent Difference (RPD), which is expressed as follows:

$$RPD = \frac{[X_1 - X_2]}{[(X_1 + X_2)/2]} X\ 100 \qquad [2]$$

where: X_1 and X_2 represent the individual values found for the target analyte in the two replicate analyses.

RPDs must be compared to the laboratory-established RPD for the analysis. For concentrations less than 10 times the method detection limit, RPD criteria are not valid, and variations may be as great as 100 percent. Precision of duplicates may again depend on sample homogeneity. Initial spike concentrations will be greater than the detection limits and will have a range comparable to those stated in SW-846 (EPA 1992).

When RPDs exceed previously established control limits, the analyst or his/her supervisor must investigate why the data exceed stated acceptance limits and report these findings to the ARI Project Manager. RPDs outside the established control limits can indicate some assignable cause, other than normal measurement errors, and the need for corrective action. Follow-up action can include recalibration, reanalysis of the matrix spike/matrix spike duplicates (MS/MSD) QC sample, environmental sample reanalysis, or flagging the data as suspect if problems cannot be resolved.

Replicate analysis of control samples will be obtained when QC samples specific to the environmental samples are analyzed. Analytical precision will be evaluated from MS/MSD RPD analyses. Use of duplicate samples during analysis can also allow a measure of precision to be determined.

Field duplicates are defined as two samples collected independently at a single sampling location during a single act of sampling. Field duplicates will make up 10 percent of the original sample number. Field duplicates will be collected for groundwater samples and analyzed for the same parameters.

A field replicate is defined as a single sample that is collected, then divided into two equal parts for the purpose of analysis. Field replicates will number 10 percent of the original sample number. Field replicates will be collected for soil/sediment samples and analyzed for the same parameters. Discretely sampled field duplicates/replicates are useful in determining sampling variability. However, greater than expected differences between replicates may occur because of variability in the sample material. In these instances, a visual examination of the sample material will be performed to document the reason for the difference. Field sample duplicates/replicates shall be used as a QC measure to monitor precision relative to sample collection activities. Analytical precision shall be evaluated using RPDs for MS/MSD, or duplicate samples.

4.2.3 Completeness

The target value for completeness of all parameters is 100 percent. Measurement data completeness is a measure of the extent that the database resulting from a specific measurement effort fulfills the objectives for the amount of data required. For this program, completeness will be defined as the valid data percentage of the total test requested as follows:

$$Completeness\ (\%) = \frac{No.\ of\ Successful\ Analyses}{No.\ of\ Requested\ Analyses}\ X\ 100 \qquad [3]$$

Successful analyses are defined as those in which the sample arrived at the laboratory intact, properly preserved, in sufficient quantity to perform the requested analyses, and accompanied by a completed Chain-of-Custody form. Furthermore, the sample must be analyzed within the specified holding time and according to QC acceptance criteria.

Completeness for the entire project also involves elements specific to field and laboratory documentation of sample collection. This includes documentation detailing whether samples and analyses specified in the *Work Plan* have been processed using the procedures outlined in this *SAP* and whether laboratory SOPs have been implemented.

Completeness values for laboratory parameters are addressed in Section 13 of this document. For the work effort at Kotzebue LRRS, a completeness value of 90 percent will be considered acceptable. Failure to achieve this goal may require resampling and reanalysis.

4.2.4 Representativeness

Representativeness describes how well the data reflect site conditions in the vicinity of the data point at the time of collection. Representativeness may be maintained or attained by careful documentation of data collection procedures and adherence to standard data collection procedures.

The characteristics of representativeness are usually not quantifiable. Subjective factors to be taken into account are as follows:

- Degree of homogeneity of a site;
- Degree of homogeneity of a sample taken from one point in a site; and
- Available information on which a sample plan is based.

Field duplicates and field replicates, as defined under precision, are also used to assess representativeness. Two samples which are collected at the same location and at the same time are considered to be equally representative of the site, at a given point in space and time. Soil borings and well locations will be chosen to represent the areas of interest at the site. To maximize representativeness of results, sampling techniques, sample size, sample locations, and depths will be carefully selected so they provide laboratory samples that are representative of the site and the specific area. Properly installed monitoring wells ensure that the water being sampled originates from the water-bearing horizon of concern. Care must by taken to ensure proper stabilization of measured water parameters, clarity, and color before groundwater samples are taken. Precautions concerning the location of internal combustion engines with respect to a well during sampling must be taken so that introduction of extraneous compounds does not affect the representativeness of the samples. Ambient condition blanks will be collected where appropriate, especially when volatile organic compounds are being analyzed. Since soil and sediment samples are less homogeneous than water, the sampler and analyst must exercise good judgment when removing a sample. Samples exhibiting obvious stratification or lithologic changes should not be used as replicates. Within ARI, precautions are taken to extract from the sample an aliquot representative of the whole sample. An aliquot is removed for analysis. For samples requiring volatile analysis, premixing or homogenizing samples will be avoided.

4.2.5 Comparability

Comparability is the degree to which data from separate data sets may be compared. For instance, sample data may be compared to data from background locations, to established criteria (e.g., Total Threshold Limit Concentrations [TTLC]), or to data from earlier sampling events. Comparability is attained by careful adherence to standardized sampling procedures and rigorous documentation of sample locations (including depth, time, and date).

Data comparability will be achieved by using standard units of measure as specified in the *Handbook*, (i.e., milligrams per liter [mg/L] for metals and inorganics in water samples, micrograms per liter [μg/L] for organics in water, and milligrams per kilograms [mg/kg] [dry weight] for both inorganics and organics in soil samples).

The use of standardized methods to collect and analyze samples (in this case, American Society of Testing and Materials [ASTM] and EPA methods), along with instruments calibrated against National Institute for Standards and Technology (NIST) and EPA-traceable standards, will also ensure comparability.

Comparability also depends on other data quality characteristics. Only when data are judged to be representative of the environmental conditions, and when precision and accuracy are known, can data sets be compared with confidence.

4.3 GOALS FOR ASSESSMENT CRITERIA

Project quality objectives for various measurement parameters associated with site characterization efforts cannot be quantified for representativeness and comparability. The following elements delineate assessment criteria discussed in detail elsewhere in the QAPP:

- Laboratory accuracy limits for ARI are presented in Section 10.0 for each method, as are analytical precision criteria;

- Overall precision for the RI/FS investigation at Kotzebue LRRS, which include both sampling and analytical factors, can be expected to show RPDs up to 40 percent for soils and 30 percent for water samples; and

- A completeness factor of 90 percent is acceptable for the RI/FS investigation of the Kotzebue LRRS.

5.0 FIELD SAMPLING PROCEDURES

5.1 SAMPLING PROTOCOLS

Section 3.2, Environmental Sampling, of the Field Sampling Plan (FSP) provides descriptions of the field sampling procedures that will be used for field activities performed during the RI/FS effort at Kotzebue LRRS.

5.2 SAMPLE HANDLING

Preservation of samples is required to retain integrity. The most common preservation techniques include pH adjustment and temperature control. Field personnel collecting environmental samples during the RI/FS effort at Kotzebue LRRS will use EPA-recommended containers and adhere to EPA-recommended preservation techniques for the parameters of concern (Table 5-1). The minimum sample volumes required for each type of analysis are also specified and must be met. Precleaned sample containers for groundwater samples, containing the appropriate preservatives as specified in Table 5-1, will be provided by ARI. Prewashed sample containers, containing the appropriate preservatives as specified in Table 5-1, will be provided by ARI.

5.3 RECORDKEEPING

This section presents the recordkeeping protocols for the project field logbook. Specifications for making corrections to logbook entries as well as for entering information regarding site photographs are also presented.

TABLE 5-1. RECOMMENDED SAMPLE CONTAINERS AND HOLDING TIMES FOR SELECTED METHODS
(Page 1 of 2)

Parameter	Container[c]	Minimum Aliquot Required[a]		Preservation[b]		Maximum Holding Times[e,f]
		Water (mL)[d]	Soil (g)[g]	Water	Soil	
Metals (6010)[g]	P,G	1,000	50	Cool 4°C HNO_3 to pH <2	4°C	6 months
Lead (7421) Modified[g]	P,G	100	10	Cool 4°C HNO_3, to pH <2	4°C	6 months
Mercury (7470/7471)[g]	P,G	1,000	10	Cool 4°C HNO_3 to pH <2	4°C	28 days
Total Petroleum Hydrocarbons (AK101, AK102)						
Gasoline	G	3 x 40	50	Cool 4°C HCl to pH <2	4°C	14 days
Diesel	G, Teflon Screw Cap	1,000	50	Cool 4°C HCl to pH <2	4°C	7 days (water) and 14 days (soil) until extraction, 40 days after extraction
Organochlorine Pesticides/PCBs (8081)	G, Teflon screw cap	1,000	50	Cool 4°C	4°C	7 days (water) and 14 days (soil) until extraction, 40 days after extraction
Volatile Organics (8260)	G, Teflon screw cap	3 x 40	50	Cool 4°C HCl to pH <2	4°C	14 days (7 days if not pH adjusted)
Semivolatile Organics (8270)	G, Teflon screw cap	2 x 1,000	50	Cool 4°C	4°C	7 days (water) and 14 days (soil) until extraction, 40 days after extraction
Total Organic Carbon (9060) Modified	G	100	10	Cool 4°C H_2SO_4 to pH <2	4°C	28 days

TABLE 5-1. RECOMMENDED SAMPLE CONTAINERS AND HOLDING TIMES FOR SELECTED METHODS
(Page 2 of 2)

[a] Additional Sample required for MS/MSD or replicate analyses.

[b] Sample preservation should be performed immediately upon sample collection. For composite chemical samples, each aliquot should be preserved at the time of collection. When use of an automatic sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining them at 4°C until compositing and sample splitting are completed.

[c] Polyethylene (P) or glass (G). Soil samples may be collected in either glass jars or stainless steel liners with both ends sealed with Teflon liner and plastic caps.

[d] Do not prewash bottle with samples.

[e] Samples should be analyzed as soon as possible after collection. The times listed are maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods of time only if the laboratory has data on file to show that the specific types of samples under study are stable for the longer time.

[f] Extraction holding times are from date of sample collection; analysis times are from date of extraction.

[g] If analyzing for dissolved metals, sample shall be filtered in the field through a 0.45 μm filter immediately (within 15 minutes) after sample collection and before sample preservation.

Source: This table includes the requirements of the U.S. Environmental Protection Agency, as published in the Code of Federal Regulations, Volume 49, Number 209, 40 CFR 136, dated October 26, 1984, page 43260.

5.3.1 Daily Logs

All information pertinent to a field and/or sampling survey will be recorded on appropriate data sheets and in a project field logbook. This field logbook will be a waterproof, bound book with consecutively numbered pages. Entries in the logbook will be made in waterproof ink and will include the following:

- Name and address of field contact (on logbook cover);
- Date of entry;
- Names and affiliations of personnel on the site;
- General description of each day's field activities;
- Documentation of weather conditions during sampling;
- Location of sampling (e.g., borehole number and proximity to nearest landmark or topographic point of reference);
- Data points for field equipment derived during calibration procedures;
- Observations of sample or collection environment;
- Identification of sampling device;
- Any field measurements made, such as ambient air monitoring or headspace analysis of soil;
- Sequence of collection of environmental samples;
- Type of sample matrix (e.g., soil, groundwater);
- Date and time of environmental sample collection;

- Field sample identification number;

- Sample distribution (e.g., laboratory, hauler);

- Sampler's name;

- Sample type (e.g., composite, normal, duplicate);

- For groundwater samples, which sample was filtered plus filter screen size and type; and

- Preservative used, if applicable, for the environmental sample.

The bottom of each page in the logbook will be signed or initialed by the person making the entries. In addition to the information entered into the logbook, the appropriate data sheets must be filled out as each activity is completed.

5.3.2 Corrections to the Logbook and Other Documents

All original data recorded in field logbooks, on sample tags, or in custody records, as well as other data sheet entries, will be written with waterproof ink. If an error is made on the document or in the logbook, corrections will be made simply by crossing a line through the error in such a manner that the original entry can still be read, and the correct information added as the change. All corrections will be initialed by the author and dated.

5.3.3 Photographs

Photographs, if taken, will be recorded in the appropriate logbook. Information to be recorded will include the following elements:

- Roll and frame number;
- Time and date;
- Photographer;
- Details for the location of the photograph;
- The subject of the photograph;

- Any significant or relevant features to note in the photograph; and
- The names of any personnel included in the photograph.

6.0 FIELD AND LABORATORY SAMPLE CUSTODY

Sample custody procedures will be based on EPA-recommended procedures (1992). As a result, emphasis is placed on careful documentation of sample collection and sample transfer. To ensure all important information pertaining to each sample is recorded, the documentation procedures described in the following sections will be implemented during collection of environmental samples.

6.1 FIELD OPERATIONS

The sample identification scheme for the work effort at the Kotzebue LRRS is described in this section. Additional detail is provided in the relevant portions of the FSP. Field sample custody procedures and documentation are also described in this section.

6.1.1 Sample Identification

Sample identification numbers will be designated with a four-part code. This code is compatible with the cell requirements for input in IRPIMS. An example of a sample designation is described as follows:

SS12-B5-10

where:

SS12	=	The specific site designation for the Kotzebue LRRS;
B5	=	The sampling activity, such as a borehole and the location; and
10	=	The depth at which the sample was taken.

Soil samples will be numbered by the sampling depth for each borehole from the surface down as sampling progresses vertically. For water samples, where the well may be sampled more than once, the consecutive number will indicate the sampling round. No numerical differentiation will be made between the replicates and duplicate samples nor for any of the QA/QC samples.

A single sample number will apply to as many sample containers required for the specified analysis for a specific environmental sample sent to ARI. The sample number, along with the date and time the sample was obtained, will be recorded on the boring log or soil/sediment sampling record and written on the sample tag. For groundwater samples which require multiple containers (usually one for each analysis), a single sample number will apply to all containers of that sample. The sample number, along with the date and time the sample was obtained, will be recorded in the field log or water sample record and written on the sample label. After collection and identification, the sample will be maintained under Chain-of-Custody procedures, as discussed in Sections 6.1.3 and 6.2.3 of this document.

6.1.1.1 Sample Labels. Samples are identified by a sample label illustrated in Figure 6-1. The information recorded on the sample tag will include the following information:

- Project identifier and project number;
- Field identification sample number;
- Date and time of sample collection;
- Name of the sampler;
- Sample matrix type and depth, as appropriate, at which the sample was obtained;
- Analyses to be performed on the sample; and
- Preservative used and, in the case of water samples, whether the sample is filtered or unfiltered.

Undisturbed Shelby tube samples collected for geotechnical analysis will be labeled appropriately for identification. The labeling of these samples will include an indication of which end of the tube represents

FLUID SAMPLE

DATE: ________ TIME: ________

TC#: ________ SAMPLER: ________

CLIENT: ________

ANALYSIS: ________

SAMPLE #: ________

FILTERED ☐

PRESERVATIVE: ________ UNFILTERED ☐

SOLID SAMPLE

TETRA TECH, INC.

DATE: ________ TIME: ________

TC#: ________ SAMPLER: ________

CLIENT: ________

ANALYSIS: ________

SAMPLE #: ________

DEPTH: ________

Figure 6-1 Sample Labels

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the top of the sampled interval; the sample interval; the boring name; the date and time of sampling; project identifier and number; and the initials of the sampler.

6.1.2 Sample Packaging and Shipping

All samples will be packaged carefully to avoid breakage or contamination, and will be shipped to the laboratory at proper temperature. The following sample packaging requirements will be followed:

- Sample bottle lids will not be mixed; all sample lids will stay with the original containers.
- All sample bottles will be wrapped in bubble pack or similar material and placed in plastic bags to minimize the potential for breakage or cross-contamination during shipment. Soil samples contained in brass or stainless steel liners will be placed in plastic bags. Volatile organic analysis sample containers will also be placed in plastic bags; activated carbon will not be used as a packaging material.
- Samples from different sites will not be intermingled in a single container; instead, separate shipping coolers will be used for samples from different sites.
- All samples will be cooled unless "no cooling" has been specified. The sample containers will be packed in a chilled cooler. Empty space in the cooler will be filled with inert packing material. Under no circumstances will locally obtained material (sawdust, sand, etc.) be used.
- The Chain-of-Custody will be placed in a plastic bag and taped to the inside of the cooler lid.
- All coolers will be custody sealed and taped with filament tape for shipment to the laboratory.
- Samples collected for geotechnical analysis will be packaged in sturdy cardboard boxes with sufficient inert packaging material to prevent sample damage.

6.1.3 Sample Custody in the Field

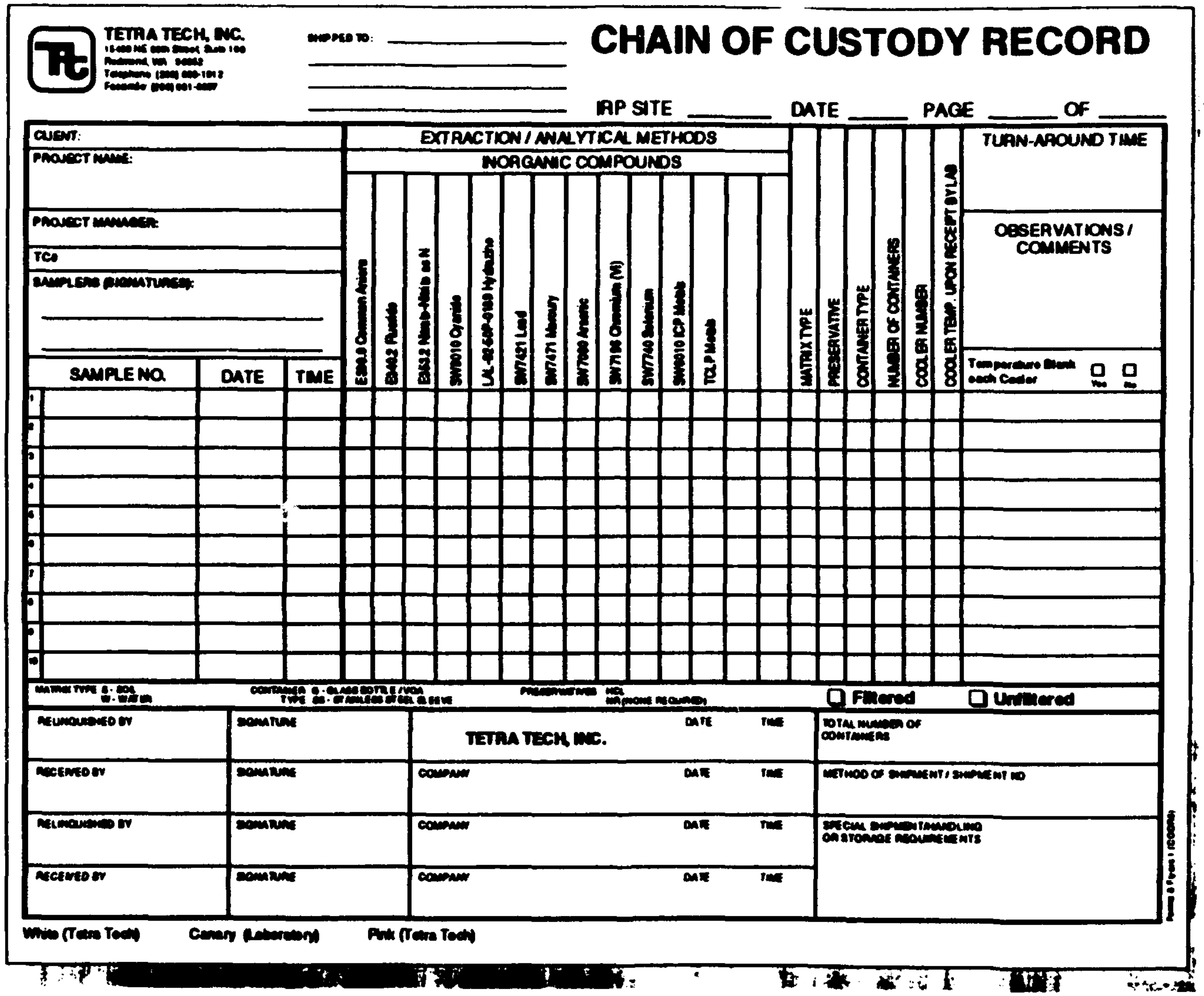
The criteria for proper sample custody are presented below. The documentation for sample custody and the protocols for custody transfer are also discussed.

6.1.3.1 ***Sample Custody.*** The following Chain-of-Custody procedures will be complied with to guarantee document sample custody. A sample will be considered under proper custody if:

- It is in actual possession of the responsible person;
- It is in view, following physical pc
- It is in the possession of a responsible person and is locked or sealed to prevent tampering; or
- It is in a secure area.

6.1.3.2 ***Chain-of-Custody.*** Sample custody is maintained by a "Chain-of-Custody Record" (Figure 6-2). The custody record is completed by the individual collecting the sample. Chain-of-Custody records will be completed for samples collected for chemical analyses and for samples collected for geotechnical analyses. Information recorded on this record will include the following:

- Date - The date the Chain-of-Custody was filled out;
- Page - The page number and total number of pages necessary to detail all samples collected during that sampling event;
- Laboratory - The name of the laboratory where the samples will be sent for analysis;
- Address - The address of the laboratory;
- Client - The client's name, Tetra Tech, Inc., will be included;



TETRA TECH, INC.

SHIPPED TO:

CHAIN OF CUSTODY RECORD

IRP SITE ______ DATE ______ PAGE ______ OF ______

CLIENT:

PROJECT NAME:

PROJECT MANAGER:

TC#

SAMPLERS (SIGNATURES):

EXTRACTION / ANALYTICAL METHODS

INORGANIC COMPOUNDS

SAMPLE NO.	DATE	TIME	E300.0 Common Anions	E340.2 Fluoride	E353.2 Nitrate-Nitrite as N	SW9010 Cyanide	LAL-92-SOP-0169 Hydrazine	SW7421 Lead	SW7471 Mercury	SW7060 Arsenic	SW7196 Chromium (VI)	SW7740 Selenium	SW6010 ICP Metals	TCLP Metals			MATRIX TYPE	PRESERVATIVE	CONTAINER TYPE	NUMBER OF CONTAINERS	COOLER NUMBER	COOLER TEMP. UPON RECEIPT BY LAB	TURN-AROUND TIME / OBSERVATIONS / COMMENTS
1																							
2																							
3																							
4																							
5																							
6																							
7																							
8																							
9																							
10																							

Temperature Blank each Cooler ☐ Yes ☐ No

MATRIX TYPE S - SOIL W - WATER

CONTAINER TYPE G - GLASS BOTTLE / VOA SS - STAINLESS STEEL SLEEVE

PRESERVATIVES HCL NR (NONE REQUIRED)

☐ Filtered ☐ Unfiltered

RELINQUISHED BY	SIGNATURE	TETRA TECH, INC.	DATE	TIME	TOTAL NUMBER OF CONTAINERS
RECEIVED BY	SIGNATURE	COMPANY	DATE	TIME	METHOD OF SHIPMENT / SHIPMENT NO
RELINQUISHED BY	SIGNATURE	COMPANY	DATE	TIME	SPECIAL SHIPMENT/HANDLING OR STORAGE REQUIREMENTS
RECEIVED BY	SIGNATURE	COMPANY	DATE	TIME	

White (Tetra Tech) Canary (Laboratory) Pink (Tetra Tech)

Figure 6-2 Sample of Typical Chain of Custody Record

- Address - The address of the client, Tetra Tech, Inc., will be listed;
- Project Name - The project title: Kotzebue LRRS, and the specific work effort;
- Project Number - This will be the time charge contract number assigned to the laboratory analysis portion of the work effort at Kotzebue LRRS;
- Method of Shipment - This will include the shipper's name and the shipping number (or the tracking number used by any other overnight delivery company) for shipment of samples to ARI or the courier if a locally available laboratory is used;
- Shipment Number - This will be a consecutive number initiated from the beginning of the project;
- Project Manager - The Project Manager's name will appear in this area;
- Telephone Number - The telephone number of the Project Manager;
- Samplers - The signatures of person(s) collecting the samples;
- Field Sample Number - The entire field sample number will be detailed on the Chain-of-Custody Record;
- Location - The location where the sample was taken from, as well as the depth, will be listed or specified by the sample numbering system;
- Date and Time - The date and time the sample was taken;
- Sample Type - The sample matrix type will be recorded;
- Type of Containers - The type of the container will be recorded;

- Type of Preservation - The preservation chemical, if necessary, will be detailed;
- Filtering - An indication will be made if the water sample has been filtered in the field;
- Number of Containers - The number of containers will be noted;
- Analysis Required - The type and method of analysis and pretreatment, if relevant, will be printed;
- Relinquished By - The signature and printed names of the person giving up the samples to the appropriate overnight delivery company officer or courier will appear in the appropriate area;
- Company - The name of the organization, Tetra Tech, Inc., giving up the samples, will be detailed;
- Reason - The reason for relinquishing the samples (e.g., transportation to a laboratory for analysis) will be noted;
- Date and Time - The date and time when the samples were relinquished will be recorded;
- Received By - This will be filled out by the laboratory personnel who receives the samples;
- Company - The name of the receiving laboratory will be recorded; and
- Comments - Any special instructions to the laboratory, such as Rush Turnaround or other relevant information concerning the samples, will be noted in this category. Comments shall also include suspected high contamination levels and high volatile content information, as noted by the field samplers.

6.1.3.3 Transfer of Custody. The field personnel who take the samples are responsible for the care and custody of the sample until it is properly transferred or delivered to the delivery agent. All samples will be accompanied by a Chain-of-Custody record. When transferring the possession of sample, the individuals relinquishing and receiving the samples will sign, date, and note the time on the Chain-of-Custody form. The company relinquishing the sample, the company receiving the sample, and the reason for transfer, as stated previously, will be noted. This record documents the transfer of samples from the custody of the sampler to that of another person.

The relinquishing individual will record specific shipping data (airway bill number, time, and date) on the original and duplicate custody forms. The Project Manager, or a specific designee is responsible for ensuring that all shipping data are consistent and placed in the permanent job file.

If sent by mail, the package will be sent by registered mail with a return receipt requested. If sent by a common carrier, a bill of lading will be retained as part of the permanent documentation.

6.2 LABORATORY OPERATIONS

6.2.1 ARI

All sample log-in, storage, and internal Chain-of-Custody documentation are the responsibility of the laboratory Sample Log-In supervisor. The Sample Log-In supervisor is responsible for retaining documents, and for verifying data entered into the sample custody records. All staff members are responsible for ensuring sample storage is secure and maintained at the proper temperature.

6.2.2 Sample Handling-ARI

Upon receipt by ARI of samples, the integrity of the shipping container will be checked and verified that the custody seal has not been broken. A Cooler Receipt Form (Figure 6-3) will be filled out. The presence of Blue Ice will be noted and temperature will be noted by measuring the accompanying temperature blank with a NIST-traceable mercury thermometer. The temperature will be entered into the Laboratory Information Management (LIM) system (Figure 6-4). If there has been a deviation from the

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COOLER RECEIPT FORM

Project: ______________________________

Cooler received on ________ **and opened on** ________ **by** ______________

____
(Signature)

1.	Were custody seals outside of cooler?	YES	NO
	If YES, how many and where? ______________		
	Were signature and date correct?	YES	NO
2.	Were custody papers taped to lid inside cooler?	YES	NO
3.	Were custody papers properly filled out (ink, signed, etc.)?	YES	NO
4.	Did you sign custody papers in the appropriate place?	YES	NO
5.	Did you attach shipper's packing slip to this form?	YES	NO
6.	What kind of packing material was used? ______________		
7.	Was sufficient ice used (if appropriate)?	YES	NO
8.	Were all bottles sealed in separate plastic bags?	YES	NO
9.	Did all bottles arrive in good condition (unbroken)?	YES	NO
10.	Were all bottle labels complete (No., date, signed, anal. pres. etc.)?	YES	NO
11.	Did all bottle labels and tags agree with custody papers?	YES	NO
12.	Were correct bottles used for the tests indicated?	YES	NO
13.	If present, were VOA vials checked for absence of air bubbles and noted if found?	YES	NO
14.	Was sufficient amount of sample sent in each bottle?	YES	NO
15.	Temperature blank in cooler?	YES	NO
16.	Temperature of temperature blank or cooler in °C? ______________		

Explain any discrepancies:

Figure 6-3 Cooler Receipt Form

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Sample Control

- Check and document physical condition of sample
- Verify documentation and parameter assignment
- Log into LIMS
- Send sample receipt acknowledgement to client

Proper Storage

- Store sample according to preservation guidelines
- Transfer sample to lab with proper documentation

Laboratories

- Prepare and analyze samples
- Document analytical work
- Return unused samples to *Sample Storage*

Sample Control

- Maintain archived samples
- Return sample to client or arrange for sample disposal

Figure 6-4 ARI Laboratory Sample Processing Flowchart

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temperature limit of 4°C ± 2°C, the Tetra Tech, Inc. Project Manager and Project QA/QC Manager will be notified immediately by telephone with a follow up hard copy description of the anomaly noted on the Cooler Receipt Form (Figure 6-3) to be sent by facsimile with a hard copy to follow in the mail. pH of all non-volatile preserved water samples will be checked upon sample receipt and log-in. pH results will be recorded on the Sample Preservation Record form.

Relevant information specific to samples received by ARI will be logged into the LIM system. The information logged will include the following items (see Figure 6-3):

- Date samples were received by ARI;
- The source of the samples;
- ARI specific sample identification;
- All analytical tests requested for that specific batch of samples;
- Number of samples associated with that specific batch; and
- Final disposition of the samples.

Samples received by ARI will be placed in the appropriate sample refrigerator that is maintained at 4°C ± 2°C. Refrigerators, including all purpose as well as those used for volatile samples, will have their temperatures noted on a daily temperature record form (Figure 6-5). Information about samples with suspected high contamination levels will be noted by the sample collectors on the Chain-of-Custody forms. Samples identified as having potentially high amounts of volatiles will be stored separately from all other samples to prevent cross-contamination. All refrigerators will be maintained at 4° ± 2°C, and the temperature will be monitored and recorded by ARI personnel on a daily basis on a data sheet specifically assigned to that refrigerator. All samples will remain in the proper environment to guarantee sample integrity until analytical and validated QA/QC results have been generated. Environmental samples whose holding times have expired may have some limited usefulness, and as such, should be discarded, but only upon confirmation from the Tetra Tech, Inc. Project Manager and Project QA/QC Manager.

6.2.3 Sample Identification

Each sample received by ARI will be given a discrete identification number to link the sample to the identity given by the Tetra Tech, Inc. sampler. The sample identification number will consist of the

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TEMPERATURE RECORD

DEPT. ____________ TEMPERATURE RANGE ________ to ________ YEAR ________

	JAN		FEB		MAR		APR		MAY		JUN	
	RECORD	INITIAL	RECORD	INITIAL	RECORD	INITIAL	RECORD	INITIAL	RECORD	INITIAL	RECORD	INITIAL
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
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28												
29												
30												
31												

Figure 6-5 Daily Temperature Record Form

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current year and a sequential number assigned by ARI to aid in tracking the sample during analysis. This unique numbering system will enable ARI to accurately track the sample as it is analyzed, dates and times of analysis, the QA/QC for that sample, and the final disposition of that sample.

6.2.4 Sample Custody Records-ARI

All samples shall be monitored using internal Chain-of-Custody logbooks (Figure 6-6). The internal Chain-of-Custody logbooks will be used to track the samples within the laboratory. All internal Chain-of-Custody logbooks will be filed permanently at ARI. The completed original Tetra Tech, Inc. sample Chain-of-Custody will be forwarded to Tetra Tech, Inc. with the final report.

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INSIDE WALK-IN LOGBOOK

Date Logged In	Log In Initials	Client Name	ARI Job No.	Sample ID	Matrix		Bin #	Removed By/Date/ID#	Returned By/Date/ID#	For Which Laboratory?	Sample shared with which lab?
					Soil	Water					

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Figure 6-6 Example of Internal Chain of Custody Logbook

7.0 CALIBRATION PROCEDURES AND FREQUENCIES FOR FIELD TEST EQUIPMENT

Field equipment and testing kits will be calibrated prior to use as relevant, in the field as detailed in Table 7-1. This will ensure that equipment used in the field will function within the tolerable range specified by the manufacturer, within the range required by the project, and that field test are accurately employed. The data points generated as a result of calibration will be recorded on calibration sheets by field personnel. Periodic calibration records will also be recorded and filed in a calibration logbook. All instruments will be monitored for evidence of nonreproducible or erratic readings, and recalibration will be performed as necessary. Calibration requirements are detailed in the Field Sampling Plan. Copies of the instrument manuals will be readily accessible for all field personnel. All records of calibration results will be subject to audit by Tetra Tech, Inc.'s Field QA Auditor.

All instruments are to be stored, transported, and handled with care to preserve equipment accuracy and minimize downtime. Damaged instruments shall be taken out of service immediately and not used again until a qualified technician repairs and recalibrates the instrument.

TABLE 7-1. FIELD INSTRUMENTATION, METHODS, DETECTION LIMITS, AND CALIBRATION PROCEDURES

Analyte	Model Number	Method of Analysis	Detection Range (mg/L)	Calibration Procedure
Hach Test Kit, Model Number S:				
Alkalinity	AL-DT	Digital Titration Against Sulfuric Acid	10-4,000	Digital Titration to Color Change
Ammonia	NI-SA	Colorimetric Against Salicylite	D-2.5	Compare to Color Disk and Record Value from Scale
Carbon Dioxide	CA-23	Titration Against NaOH and Phenolphthalein	1.25-100	Drop Count Titration to Color Change
Chloride (two levels)	8-P	Titration Against Silver Nitrate	5-100 20-400	Drop Count Titration to Color Change
Nitrate	NI-1.1	Colorimetric With Cadmium Reduction	D-1.0	Compare from Color Disk and Record Value from Scale
Nitrite	NI-15	Colorimetric with Diazotization	D-0.5	Compare from Color Disk and Record Value from Scale
Phosphate	PC-19	Colorimetric with Ascorbic acid	D-50	Compare from Color Disk and Record Value from Scale
Sulfate	SF-1	Extinction and Turbimetric Processes	50-200	Graduated Scale Read Through Turbidity
Sulfide (single level)	HS-C	Color Chart Against Carbonate Reaction with Hydrogen Sulfide	D-5	Comparison to Color Chart
Sulfide (multi-level)	HS-WR	Colorimetric Against Methylene Blue	D-0.55 D-2.25 D-11.25	Compare to Color Disk and Record Value from Scale
Direct Measurement Instrumentation:				
Conductivity	EPA Method 120, Model YSI 3000	Selective Ion Electrode	D-50,000[a]	Calibrate as per Manufacturer's Instructions
Dissolved Oxygen	YSI Model 51B	Selective Ion Electrode	D-15	Calibrate by either Winkler Titration, Air Method, or Saturated Water Method
pH	EPA Method 150.1, Model Orion SA 250	Selective Ion Electrode	(-2)-19.9[b]	Autocalibration to Manufacturer's Specification
Temperature	EPA Method 170.1, Model YSI 3000	Thermometer	-2° C-50 C°	Calibrate as per Manufacturer's Instructions

Notes: D = Limit of Detection.

[a] Units are in micromhos/cm.

[b] By convention, no units are used for pH.

8.0 ANALYTICAL PROCEDURES

Target analytes and the analytical methods used by ARI for the RI/FS effort at Kotzebue LRRS are presented in Table 8-1. For each analysis, the following information is included in Table 8-1: parameter name, reference and method number, the matrix, analyte of interest, and matrix-specific reporting limits. The terminology and how the limits were determined are described in Section 8.2. The reporting limits presented in Table 8-1 are based on experimentally derived MDL studies as found in Appendix B.

Table 8-2, in combination with Section 10.0 of this QAPP, provide QC criteria for the analytical program used with the RI/FS effort at Kotzebue LRRS. There may be instances where high analyte concentrations, nonhomogeneity of samples, or matrix interferences preclude achieving the detection limits or associated QC criteria. In such instances, the reason for deviations from the detection limits or associated QC criteria will be reported in Corrective Action and Analyst Notes Reports to the ARI Project Manager and in the laboratory QC report, which are described in detail in Section 15.0 of this QAPP.

8.1 ANALYTICAL METHODS

Standard analytical methods to be used for the sample analyses are referenced in the following documents:

- *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, SW-846*, 3rd Edition (Environmental Protection Agency 1992);

- *Methods for Chemical Analysis of Water and Wastes* (Environmental Protection Agency 1983);

- *State of Alaska Methods for the Determination of Gasoline Range and Diesel Range Organics* (February 1992).

TABLE 8-1. ARI PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET ANALYTES (Page 1 of 9)				
Parameters	Method W=Water S=Soil	Analyte	Water (mg/L)	Soil (mg/kg)
Total Petroleum Hydrocarbons	SW5030/AK101	Gasoline	0.4	6
	SW3550/AK102	Diesel	0.2	3
Total Organic Carbon	SW9060 Modified	Total Organic Carbon	0.6	560
Metals	SW7421 Modified	Lead	0.004	0.4
	SW7470(W)	Mercury	0.00006	NA
	SW7471(S)	Mercury	NA	0.03
	SW6010	Antimony	0.1	10
	SW6010	Arsenic	0.1	10
	SW6010	Barium	0.01	1
	SW6010	Beryllium	0.001	0.1
	SW6010	Cadmium	0.02[b]	2
	SW6010	Chromium	0.006	0.6
	SW6010	Cobalt	0.01	1
	SW6010	Copper	0.002	0.2
	SW6010	Lead	0.04	4
	SW6010	Molybdenum	0.007	0.7
	SW6010	Nickel	0.02	2
	SW6010	Selenium	0.1	10
	SW6010	Silica	0.4	NA
	SW6010	Silver	0.004	0.4
	SW6010	Thallium	0.04	4
	SW6010	Vanadium	0.004	0.4
	SW6010	Zinc	0.008	0.8
	SW6010	Aluminum	0.03	3
	SW6010	Calcium	0.07	7
	SW6010	Iron	0.02	2
	SW6010	Magnesium	0.04	4

TABLE 8-1. ARI PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET ANALYTES (Page 2 of 9)				
Parameters	Method W=Water S=Sc	Analyte	Water (mg/L)	Soil (mg/kg)
Metals (Cont.)	SW6010	Manganese	0.01	1
	SW6010	Potassium	0.5	50
	SW6010	Sodium	0.2	20

TABLE 8-1. ARI PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET ANALYTES (Page 3 of 9)				
Parameters	Method W=Water S=Soil	Analyte	Water (µg/L)	Soil (mg/kg)
Organochlorine Pesticides & PCBs	SW3510/SW8081(W) SW3550/SW8081(S) (cap col.)	Aldrin	0.02	0.00020
		alpha-BHC	0.01	0.00020
		beta-BHC	0.01	0.00031
		delta-BHC	0.01	0.00032
		gamma-BHC (Lindane)	0.01	0.00025
		Chlordane (alpha)	0.01	0.00020
		4,4'-DDD	0.017	0.0004
		4,4'-DDE	0.029	0.0003
		4,4'-DDT	0.031	0.0007
		Dieldrin	0.02	0.0004
		Endosulfan I	0.01	0.00036
		Endosulfan II	0.021	0.0005
		Endrin aldehyde	0.031	0.0003
		Endrin	0.014	0.0003
		Endosulfan sulfate	0.01	0.0008
		Heptachlor	0.01	0.0003
		Heptachlor epoxide	0.01	0.00025
		Methoxychlor	0.12	0.0027
		Chlordane (gamma)	0.01	0.00017
		Toxaphene	0.79	0.02
		PCB-1016	0.9	0.03
		PCB-1221	0.8	0.03
		PCB-1232	0.8	0.01
		PCB-1242	0.7	0.02
		PCB-1248	0.8	0.01
		PCB-1254	1.0	0.03
		PCB-1260	1.0	0.03
Volatile Organic Compounds	SW5030/SW8260(W)(S)	Acetone	9	0.01
		Benzene	2	0.0015
		Bromodichloromethane	2	0.002
		Bromoform	2	0.004
		Bromomethane	2	0.003

TABLE 8-1. ARI PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET ANALYTES (Page 4 of 9)				
Parameters	Method W=Water S=Soil	Analyte	Water (µg/L)	Soil (mg/kg)
Volatile Organic Compounds (Cont.)	SW5030/SW8260(W)(S)	Bromochloromethane	1	0.002
		2-Butanone (MEK)	2	0.008
		Carbon disulfide	2	0.002
		Carbon tetrachloride	2	0.003
		Chlorobenzene	1	0.002
		Chloroethane	2	0.003
		Chloroform	1	0.001
		Chloromethane	3	0.003
		1,1-Dichloroethane	2	0.001
		1,2-Dichloroethane	2	0.002
		1,1-Dichloroethene	2	0.004
		cis-1,2-Dichloroethene	2	0.004
		trans-1,2-Dichloroethene	1	0.003
		1,2-Dichloropropane	2	0.003
		cis-1,3-Dichloropropene	1	0.002
		trans-1,3-Dichloropropene	2	0.002
		Ethylbenzene	1	0.0014
		2-Hexanone	2	0.009
		Methylene chloride	1	0.003
		4-Methyl-2-pentanone (MIBK)	4	0.005
		Styrene	1	0.002
		1,1,2,2-Tetrachloroethane	2	0.0029
		Tetrachloroethene	1	0.003
		Toluene	2	0.0029
		1,1,1-Trichloroethane	2	0.001
		1,1,2-Trichloroethane	1	0.002
		1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	1	0.002
		Trichloroethene	1	0.002
		Vinyl acetate	2	0.005
		Vinyl chloride	2	0.003
		Xylenes (total, all isomers)	2	0.003
		Bromobenzene	2	0.0023

TABLE 8-1. ARI PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET ANALYTES
(Page 5 of 9)

Parameters	Method W=Water S=Soil	Analyte	Water (μg/L)	Soil (mg/kg)
Volatile Organic Compounds (Cont.)	SW5030/SW8260(W)(S)	2-Chloroethyl vinyl ether	3	0.002
		1-Chlorohexane	5	0.002
		1,1,1,2-Tetrachloroethane	2	0.003
		1,2,3-Trichloropropane	1	0.007
Semivolatile Organic Compounds	SW3550/SW8270(S) SW3520/SW8270(W)	**Base/Neutral Extractables**		
		Acenaphthene	2	0.1
		Acenaphthylene	2	0.1
		Anthracene	2	0.1
		Benzo(a)anthracene	2	0.1
		Benzo(b)fluoranthene	2	0.1
		Benzo(k)fluoranthene	3	0.2
		Benzo(g,h,i)perylene	2	0.1
		Benzo(a)pyrene	2	0.1
		Benzyl alcohol	2	0.2
		bis(2-chloroethoxy) methane	2	0.1
		bis(2-ethylhexyl) phthalate	2	0.1
		bis(2-chloroethyl) ether	6	0.1
		bis(2-chloroisopropyl) ether	2	0.1
		4-Bromophenyl phenyl ether	2	0.1
		Butyl benzyl phthalate	2	0.1
		4-Chloroaniline	6	0.3
		2-Chloronaphthalene	2	0.1
		4-Chlorophenyl phenyl ether	2	0.1
		Chrysene	2	0.1
		Dibenzo(a,h) anthracene	2	0.1
		Dibenzofuran	2	0.1
		1,2-Dichlorobenzene	1	0.1
		1,3-Dichlorobenzene	1	0.1
		1,4-Dichlorobenzene	1	0.1
		3,3'-Dichlorobenzidine	7	0.2
		Diethyl phthalate	3	0.1
		Dimethyl phthalate	2	0.1
		2,4-Dinitrotoluene	4	0.1

TABLE 8-1. ARI PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET ANALYTES
(Page 6 of 9)

Parameters	Method W=Water S=Soil	Analyte	Water (μg/L)	Soil (mg/kg)
Semivolatile Organic Compounds (Cont.)	SW3550/SW8270(S) SW3520/SW8270(W)	2,6-Dinitrotoluene	5	0.1
		Fluoranthene	2	0.1
		Fluorene	2	0.1
		Hexachlorobenzene	2	0.1
		Hexachlorobutadiene	2	0.1
		Hexachlorocyclopentadiene	9	0.1
		Hexachloroethane	2	0.1
		Indeno(1,2,3-cd)pyrene	2	0.1
		Isophorone	2	0.1
		2-Methylnaphthalene	2	0.1
		Naphthalene	1	0.1
		2-Nitroaniline	4	0.06
		3-Nitroaniline	20	0.35
		4-Nitroaniline	10	0.42
		Nitrobenzene	1	0.1
		N-nitrosodiphenylamine	2	0.3
		N-nitrosodipropylamine	4	0.1
		Phenanthrene	2	0.1
		Pyrene	2	0.1
		Di-n-octylphthalate	2	0.1
		Di-n-butylphthalate	3	0.2
		1,2,4-Trichlorobenzene	1	0.1
		Acid Extractables		
		Benzoic Acid	10	0.18
		4-Chloro-3-methylphenol	3	0.2
		2-Chlorophenol	1	0.2
		2,4-Dichlorophenol	3	0.1
		2,4-Dimethylphenol	8	0.3
		4,6-Dinitro-2-methylphenol	9	0.28
		2,4-Dinitrophenol	30	0.28
		2-Methylphenol	1	0.3
		4-Methylphenol	2	0.2
		2-Nitrophenol	2	0.1

TABLE 8-1. ARI PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET ANALYTES
(Page 7 of 9)

Parameters	Method W=Water S=Soil	Analyte	Water (µg/L)	Soil (mg/kg)
Semivolatile Organic Compounds (Cont.)	SW3550/SW8270(S) SW3520/SW8270(W)	4-Nitrophenol	5	0.21
		Pentachlorophenol	10	0.10
		Phenol	3	0.2
		2,4,5-Trichlorophenol	4	0.08
		2,4,6-Trichlorophenol	5	0.1

TABLE 8-1. ARI PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET ANALYTES (Page 8 of 9)				
Parameters	Method W=Water S=Soil	Analyte	TCLP Extract (mg/L)	Soil (mg/kg)
Toxicity Characteristic Leaching Procedure	SW1311/SW6010	Arsenic	0.1	NA[a]
	SW1311/SW6010	Barium	0.01	NA[a]
	SW1311/SW6010	Cadmium	0.02[b]	NA[a]
	SW1311/SW6010	Chromium	0.006	NA[a]
	SW1311/SW6010	Lead	0.042	NA[a]
	SW1311/SW7470	Mercury	0.00006	NA[a]
	SW1311/SW6010	Selenium	0.1	NA[a]
	SW1311/SW6010	Silver	0.004	NA[a]
	SW1311/SW8081	Endrin	0.000014	NA[a]
	SW1311/SW8081	Lindane	0.00001	NA[a]
	SW1311/SW8081	Methoxychlor	0.00012	NA[a]
	SW1311/SW8081	Toxaphene	0.00079	NA[a]
	SW1311/SW8150	2,4-D	0.0046	NA[a]
	SW1311/SW8150	2,4,5-TP (Silvex)	0.0089	NA[a]
	SW1311/SW8260	Benzene	0.002	NA[a]
	SW1311/SW8260	Carbon tetrachloride	0.002	NA[a]
	SW1311/SW8081	Chlordane	0.00001	NA[a]
	SW1311/SW8260	Chlorobenzene	0.001	NA[a]
	SW1311/SW8260	Chloroform	0.001	NA[a]
	SW1311/SW8270	o-Cresol	0.001	NA[a]
	SW1311/SW8270	m,p-Cresol	0.002	NA[a]
	SW1311/SW8270	1,4-Dichlorobenzene	0.001	NA[a]
	SW1311/SW8260	1,2-Dichloroethane	0.002	NA[a]
	SW1311/SW8260	1,1-Dichloroethylene	0.002	NA[a]
	SW1311/SW8270	2,4-Dinitrotoluene	0.004	NA[a]
	SW1311/SW8081	Heptachlor (and its epoxide)	0.00001	NA[a]
	SW1311/SW8270	Hexachlorobenzene	0.002	NA[a]
	SW1311/SW8270	Hexachloro-1,3-butadiene	0.002	NA[a]
	SW1311/SW8270	Hexachloroethane	0.002	NA[a]
	SW1311/SW8260	Methyl ethyl ketone	0.002	NA[a]
	SW1311/SW8270	Nitrobenzene	0.001	NA[a]

TABLE 8-1. ARI PRACTICAL QUANTITATION LIMITS (PQLs) FOR TARGET ANALYTES
(Page 9 of 9)

Parameters	Method W=Water S=Soil	Analyte	TCLP Extract (mg/L)	Soil (mg/kg)
Toxicity Characteristic Leaching Procedure (Cont.)	SW1311/SW8270	Pentachlorophenol	0.01	NA[a]
	SW1311/SW8270	Pyridine	0.01[c]	NA[a]
	SW1311/SW8260	Tetrachloroethylene	0.001	NA[a]
	SW1311/SW8260	Trichloroethylene	0.001	NA[a]
	SW1311/SW8270	2,4,5-Trichlorophenol	0.004	NA[a]
	SW1311/SW8270	2,4,6-Trichlorophenol	0.005	NA[a]
	SW1311/SW8260	Vinyl Chloride	0.002	NA[a]

[a] NA = Not applicable.

[b] Exceeds Handbook MQL.

[c] Interim limits.

Notes: 3510: EPA method 3520 will be substituted when emulsions are encountered and during periods of high sample throughput when 3510 capacity is exceeded.

The methods cited are from the following sources:

E Methods - Methods for Chemical Analysis of Water and Wastes, EPA Manual, 600/4-79-020 (Environmental Protection Agency 1983--with additions).

SW Methods - Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition (Environmental Protection Agency 1992).

TABLE 8-2. SUMMARY OF CALIBRATION PROCEDURES
(Page 1 of 4)

Method and Instrument	Parameter	Calibration	Frequency	Acceptance Criteria	Corrective Action
1311 (TCLP)[a]	NA	NA	NA	NA	NA
6010 (ICP)	Metals, Total and Dissolved	Initial calibration standards	Prior to analysis	Measured value for calibration standard ±10% of expected value[b]	Recalibrate if appropriate
		Initial calibration verification	After initial calibration standards	±10%	1) Check calculations 2) Troubleshoot instrument 3) Recalibrate as necessary
		Initial method blank	After initial calibration verification	3 Standard deviations of mean blank value	1) Correct source of contamination 2) Recalibrate as necessary
		Interference check standards	After initial method blank and before final continuing calibration verification	±20% for EPA check sample elements	1) Troubleshoot instrument 2) Recalibrate as necessary
		Continuing calibration verification	After every 10 samples	±10%	1) Troubleshoot instrument 2) Corrective action 3) Recalibrate as necessary 4) Reanalyze affected samples
		Continuing calibration blank	10%	3 Standard deviations of mean blank value	1) Correct source of contamination 2) Recalibrate as necessary 3) Reanalyze affected samples
7421	Pb	Initial calibration standards, minimum three points	Prior to analysis	$r \geq 0.995$	1) Check calculations 2) Troubleshoot instrument 3) Recalibrate as necessary
		Initial calibration verification	After initial calibration standards	±10%	1) Check calculations 2) Troubleshoot instrument 3) Recalibrate as necessary
		Initial method blank	After initial calibration verification	≤3x MDL	1) Correct source of contamination 2) Recalibrate as necessary

TABLE 8-2. SUMMARY OF CALIBRATION PROCEDURES
(Page 2 of 4)

Method and Instrument	Parameter	Calibration	Frequency	Acceptance Criteria	Corrective Action
7421 (Cont.)	Pb (Cont.)	Continuing calibration verification	After every 10 samples	±10%	1) Troubleshoot instrument 2) Corrective action 3) Recalibrate as necessary 4) Reanalyze affected samples
		Continuing calibration blank	After every 10 samples	≤3x MDL	1) Correct source of contamination 2) Recalibrate as necessary 3) Reanalyze affected samples
7470/7471	Hg	Initial calibration standards, minimum five points	Prior to analysis	r≥0.995	1) Check calculations 2) Troubleshoot instrument 3) Recalibrate as necessary
		Initial calibration verification	After initial calibration standards	±20%	1) Check calculations 2) Troubleshoot instrument 3) Recalibrate as necessary
		Initial method blank	After initial calibration verification	≤3x MDL	1) Correct source of contamination 2) Recalibrate as necessary
		Continuing calibration verification	After every 10 samples	±20%	1) Troubleshoot instrument 2) Corrective action 3) Recalibrate as necessary 4) Reanalyze affected samples
		Continuing calibration blank	After every 10 samples	≤3x MDL	1) Correct source of contamination 2) Recalibrate as necessary 3) Reanalyze affected samples
8081 (cap. column) (GC/ECD) 8150/TCLP[c] (GC/ECD)	Organochlorine Pesticides and PCBs Organochlorine Herbicides	Minimum five points	Initially and as required	≤% RSD 20% (average calibration factor)	1) Rerun 2) Recalibrate as necessary 3) Reanalyze all affected samples
		Calibration blank	Initially and as required	≤3 x MDL	1) Rerun until clean blank is reached
		Continuing calibration verification	Every 10 samples and at the end of the analytical run	±15%	1) Evaluate system 2) Reanalyze standard 3) Recalibrate if appropriate

TABLE 8-2. SUMMARY OF CALIBRATION PROCEDURES
(Page 3 of 4)

Method and Instrument	Parameter	Calibration	Frequency	Acceptance Criteria	Corrective Action
8081 (cap. column) (GC/ECD) 8150/TCLP (Cont.)	Organochlorine Pesticides and PCBs (Cont.)	5-point calibration for Aroclor Mix 1016/1260. Single medium level for all other Aroclors. If PCB is detected, that Aroclor will be run as a continuing calibration within 24 hours.	As required	%RSD ≤ 30%	1) Recalibrate as necessary
8260 (GC/MS) (Cap. Column)	Volatile Organics	Check for mass spectral for intensities using BFB	Every 12 hours	As per SOP	1) Retune instrument 2) Repeat BFB analysis 3) Reanalyze all affected samples
		Initial calibration, minimum five points	Initially and as required	CCCs: %RSD < 30 SPCCs: RRF > 0.300 (0.25 for Bromoform)	1) Evaluate system 2) Recalibrate if appropriate 3) Reanalyze all affected samples
		Calibration blank	Initially and as required	≤ 3 x MDL	1) Rerun until clean blank is reached
		Continuing calibration check standard	Every 12 hours	% difference ≤ 25% for 1,1-dichlorothene, chloroform, 1,2-dichloropropane, toluene, ethylbenzene, and vinyl chloride	1) Evaluate system 2) Repeat calibration 3) Reanalyze all affected samples
		System performance check compounds	Every 12 hours	Minimum RF of 0.300 (0.250 for bromoform), (0.100 for chlorometh-ane), 1,1-dichloroeth-ane, bromoform, 1,1,2,2-tetrachloroeth-ane, and chlorobenzene	1) Evaluate system 2) Repeat calibration if appropriate 3) Reanalyze all affected samples
8270 (GC/MS)	Semivolatile Organics	Check of instrument tuning criteria using DFTPP	Every 12 hours	Refer to Method in SW846	1) Retune instrument 2) Repeat DFTPP analysis 3) Reanalyze all affected samples
		Initial calibration, minimum five points	Initially and as required	% RSD for CCCs ≤ 30% Avg. RF ≥ 0.050 SPCCs	1) Evaluate system 2) Recalibrate if appropriate 3) Reanalyze all affected samples

TABLE 8-2. SUMMARY OF CALIBRATION PROCEDURES
(Page 4 of 4)

Method and Instrument	Parameter	Calibration	Frequency	Acceptance Criteria	Corrective Action
8270 (GC/MS) (Cont.)	Semivolatile Organics (Cont.)	Calibration blank	Initially and as required	≤3 x MDL	1) Rerun until clean blank is reached
		Continuing calibration check standard	Every 12 hours	RF ≥0.050 for SPCCs % Difference <30% for CCCs	1) Evaluate system 2) Repeat calibration check 3) Recalibrate if appropriate 4) Reanalyze all affected samples
		System performance check compounds	Every 12 hours	RF ≥0.050	1) Evaluate system 2) Repeat calibration if appropriate 3) Reanalyze all affected samples
		Calibration check compounds	Every 12 hours	% Difference <30%	1) Evaluate system 2) Repeat calibration if appropriate 3) Reanalyze all affected samples
9060 (Combustion)	Total Organic Carbon	Multipoint calibration (standard and blank)	Daily, prior to analysis		Recalibrate as necessary
		Calibration verification	10% and at end of run	±20%	Repeat calibration as appropriate
		Calibration verification blank	10% and at end of run	≤3 x MDL	1) Evaluate system 2) Repeat calibration 3) Reanalyze all affected samples
		Linearity check standard	Daily	R ≥0.995	Repeat calibration as appropriate
AK101/AK102	Total Petroleum Hydrocarbons	Minimum three points each of gasoline and/or diesel	Initially and as required	RSD ≤25%	1) Evaluate system 2) Repeat calibration 3) Reanalyze all affected samples
		Calibration blank	Initially and as required	≤3 x MDL	1) Rerun until clean blank is reached

[a] The calibration criteria for TCLP samples extracted by EPA Method 1311 are as specified for that method found earlier in this table.
[b] EPA Method 6010 specifies a single point calibration due to the linearity of the ICP instrumentation.
[c] EPA Method 8150 will be performed for 2,4,5-TP (Silvex) and 2,4-D as specified for Toxicity Characteristic Leachate Procedure waste characterization only.
NA = Not applicable.

The rationale for the selection of the parameters and methods used for the RI/FS investigation are described in detail in the Work Plan; however, a brief discussion is provided in this QAPP.

8.1.1 Metals, Metalloids, and Nonmetal Analyses

Water and soil samples will be analyzed for lead by Graphite Furnace Atomic Absorption Spectroscopy (GFAA) by EPA Modified Method 7421. Mercury will be analyzed by cold vapor atomic absorption spectroscopy using Methods 7470 for water and 7471 for soil. The remaining metals will be determined by Inductively Coupled Plasma Emission Spectroscopy (ICP), Method 6010. The preparation method of the sample for ICP and GFAA is dependent on matrix type and analytical technique. For soils, only one digestion is required, EPA Method 3050. Water samples require two preparations, one for ICP and one for lead analysis. For ICP analysis the dissolved metal and total antimony samples are digested following Method 3005 and all other total metals following 3010. For GFAA analysis, EPA Method 3020 is utilized for total and dissolved lead. For soil samples requiring a toxicity characteristic leachability profile, EPA Method 1311 will be used to extract the sample. The subsequent analysis will be by the specified EPA Method.

8.1.2 Organic Analysis

Soil and water samples will be analyzed for gasoline and diesel-range Total Petroleum Hydrocarbons by State of Alaska Methods AK101 and AK102, respectively. The SOP for AK101 and AK102 are included in Appendix B of this document. The pretreatment procedure for AK101 will be performed by ARI as detailed in their SOP number 422S found in Appendix B. No field pretreatment will be performed. After pretreatment, the samples will be extracted via purge and trap (SW 5030) and analyzed as per AK101. If AK102 results in soil samples indicate that there are fuel hydrocarbons greater than C_{28}, the AK102 Method will be extended to evaluate residual range organics through C_{40}. Volatile organics in soil and water samples will be analyzed by EPA Method 8260, with a modified analyte list corresponding to SW8010 and SW8020. Semivolatile compounds in water will be extracted by EPA Method 3520. If necessary, samples will undergo Gel-Permeation Cleanup (GPC) using EPA Method SW3640. Semivolatile compounds, chlorinated pesticides, and PCBs in soil will be extracted by EPA Method SW3550 and then each soil sample will undergo GPC using EPA Method SW3640. Chlorinated pesticides and PCBs will be extracted from water by EPA Method SW3510. If necessary, samples will undergo GPC using EPA Method SW3640. Soil and water samples will then be analyzed by EPA Method SW8270 for semivolatile organic compounds and EPA Method SW8081 for chlorinated pesticides and PCBs. For all samples analyzed by GC where positive results are encountered, second column analysis will be performed to confirm the presence and amount of those results. Total organic carbon will be analyzed for in soil and water samples using EPA Method 9060 which has been modified to include soils. EPA Method 8150 will be used to determine the presence of chlorinated herbicides in TCLP extracts. Method specific analytes found in EPA Methods 8260, 8270, 8081 associated with TCLP analysis will also be performed for select samples.

8.1.3 Analysis Performed in the Field

Field measurements for alkalinity, ammonia, carbon dioxide, chloride anions, nitrate, nitrite, phosphate, sulfate, and sulfide will be accomplished using HACH Field Test Kits. The detection limits and cal bration procedures for this field measurement are detailed in Table 7-1. Direct measurements will also be performed in the field and include temperature (EPA Method 170.1), pH (EPA Method 150.1), specific conductance (EPA Method 120.1), and dissolved oxygen.

8.2 DETECTION LIMITS

Detection limits are required for all methods of quantitative analysis to evaluate each method's performance. Detection limits for many analytical procedures depend highly on the matrix of the sample or material that is tested. Interferences frequently require sample dilution and/or method modifications that may change the practical quantitation limits. Statistical method detection limit (MDL) studies are performed according to 40 CFR 136, by analysis of a standard solution with each analyte in reagent water, or matrix, if appropriate, at a concentration of one to five times the expected detection limit, with seven consecutive measurements on one day Limits are calculated as standard deviation multiplied by the Student's t test value for n-1 degrees of freedom. Practical Quantitation Limits (PQLs) are determined to be 10 times the standard deviation of the seven consecutive measurements.

8.3 CALIBRATION PROCEDURES AND FREQUENCIES

Analytical instruments shall be calibrated periodically using EPA-traceable standards in accordance with the specified analytical methods. Table 8-2 provides a summary of calibration practices used by ARI.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

9.1 DATA MANAGEMENT

Data storage and documentation will be maintained using logbooks and data sheets that will be kept on file at ARI. All computer-generated raw data are stored on magnetic tape, or other media and will be maintained, along with paper copies by ARI and for one year after completion of all analytical tasks.

9.2 DATA REDUCTION

Data reduction calculations to be used on data generated during sample collection at Kotzebue LRRS are part of ARI's SOP. All data generated will have units consistent with those specified in the *Handbook*.

9.3 DATA QUALITY ASSESSMENT

9.3.1 ARI

After samples are extracted and analyzed, the ARI Analyst generates the appropriate laboratory data (Table 9-1). The Analyst is also responsible for the first level of data review (see Table 9-1). Control charts and analytical notes are maintained by the Analyst. The Analyst also initiates any discrepancy notification if warranted (see Table 9-1).

The Supervisor of that particular section oversees daily analytical activities. Analyst notes containing QC notes and narrative notes detailed by the Analyst are reviewed by the Supervisor or Senior Chemist (see Table 9-1). The LIMS data generated by the analyst, as well as corrective actions, are also reviewed and validated by the Supervisor or Senior Chemist. Daily quality control, such as calibration curves, is also

TABLE 9-1. ANALYTICAL DATA REVIEW PROCESS, ARI	
	Responsibilities
Analyst	• Sample analysis and raw data generation • Data review - 1st level (bench) • Control charting/verification of acceptable QC results • Analytical notes • Data entry into LIMS • Discrepancy initiation and documentation of corrective actions • Provide copies of log books, as necessary
Supervisor	• Oversee daily analytical activities
Section Manager	• Ensure program compliance • Review discrepancies requiring manager resolution • Technical conference calls with client
Data Reporting and Review	• Generate data reports • Generate forms package • Final data review and validate • Electronic deliverables generation • Data validation • Review of analyst notes and corrective action reports • Supervise contractual and technical compliance • Discrepancy review • Review quality control daily (calibrations, etc.) • Ensure technical validity of data
Quality Assurance	• 10 percent contractual compliance review (data packages) - Custody when required; - Calculations; - Methods criteria; - QC criteria; - Forms; and - Control charting. • QA auditing
Project Manager	• Review and summarize analyst notes/corrective actions • Review packages for completeness and quality • Cover letter/case narrative • Collate organic and inorganic packages • Client/laboratory liaison • Prepare package and paginate • Maintain data package files • Deliver package to client

reviewed by the Supervisor (see Table 9-1). The Supervisor is also responsible for ensuring contractual and technical compliance associated with the samples collected at Kotzebue LRRS.

The Project Manager prepares the case narrative using all analytical notes and corrective action documentation. Program compliance is ensured by the Manager and Supervisor (see Table 9-1). The Manager will also confer with Tetra Tech, Inc.'s QA/QC staff regarding technical issues.

Data Review Staff have final data review and validation responsibilities (Table 9-1). Data reporting staff generate data reports and forms packages, and also assist with electronic deliverables generation.

The QA Officer ensures that there has been at least 10 percent contractual compliance review of the data package (see Table 9-1). The QA officer reviews items in the data package such as calculations, determines if both QC and method criteria have been met, and checks that the proper forms have been used and the control criteria have been adequately detailed (see Table 9-1). The QA officer periodically conducts audits to verify compliance with established procedures.

The ARI Project Manager prepares the case narrative and package, reviews the data package for completeness and quality as well as the narrative for accuracy (see Table 9-1). The Project Manager also serves as a liaison between the laboratory and Tetra Tech, Inc. Final data package including a cover letter will be sent to Tetra Tech, Inc. by the Project Manager (see Table 9-1).

At any level during data review, if a condition adverse to quality is identified, a corrective action may be initiated to return the data to a satisfactory status (Figure 9-1). The situation is analyzed for both incidental conditions as well as chronic trends that have effected the quality of the data being generated. The impact of the condition is evaluated and if deemed to have no adverse effect to the quality of the data, the investigation is closed with written narrative to support the decision (Figure 9-1). If the condition is deemed to cause adverse effects to the quality of the data, the relevant manager is notified and the following steps are taken:

- The cause of the adverse effect is determined;
- Any impacts to the data are evaluated;

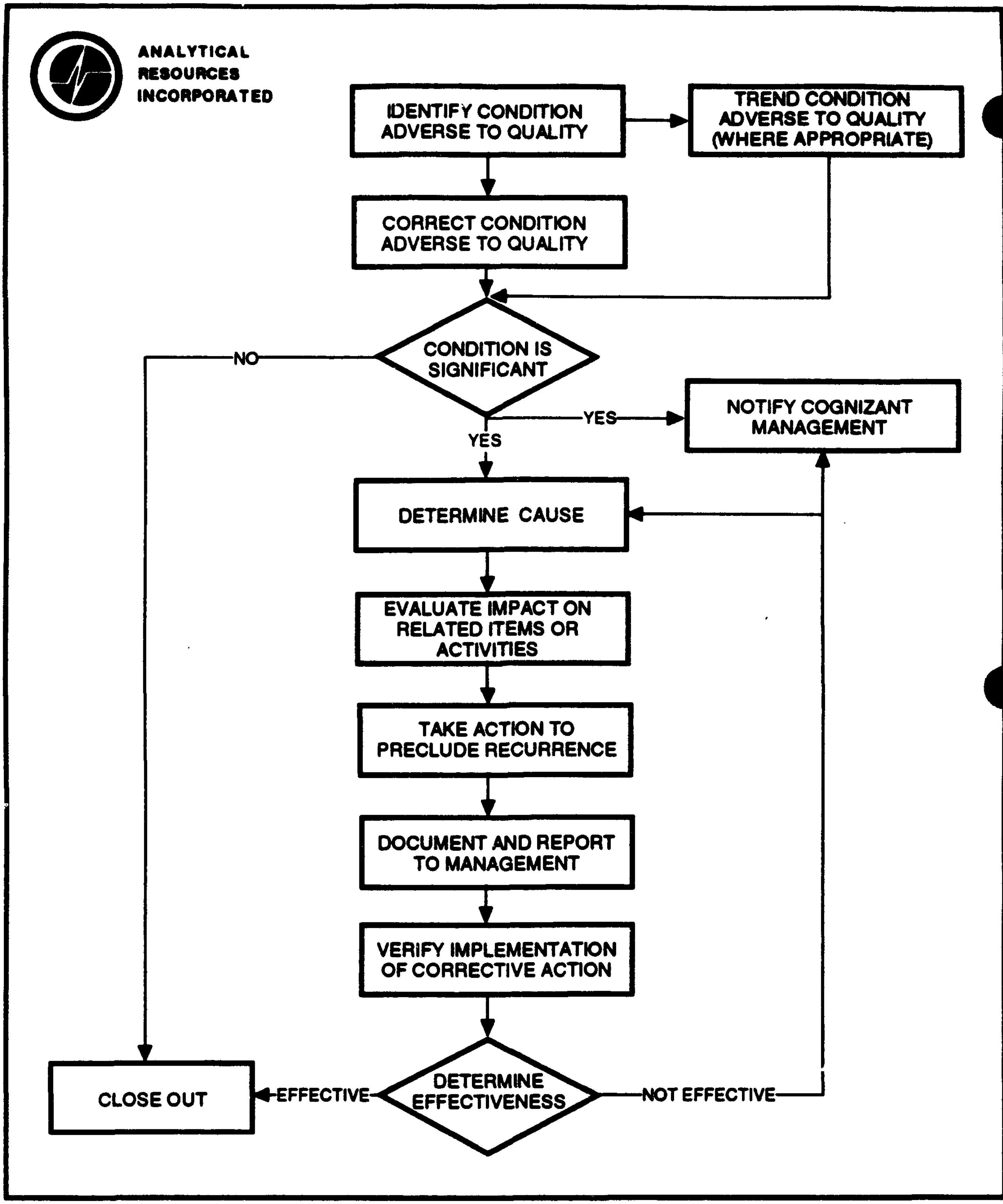

Figure 9-1. Corrective Action Flowchart

- Corrective actions are taken to preclude a recurrence of the adverse effect;

- The adverse condition as well as the steps taken to alleviate this condition are documented and reported to the appropriate manager; and

- The implementation of the corrective action is verified (Figure 9-1).

Once the corrective action has been determined to be effective, the case is closed out with written narrative documenting all steps taken. If the corrective action is determined to not be effective, the appropriate manager is notified and the corrective action steps are again repeated (Figure 9-1).

9.3.2 Tetra Tech, Inc.

Validation of data generated by ARI is the responsibility of Tetra Tech, Inc.'s Project QA/QC Manager, and data Management Manager. Validation activities will be performed according to the *Handbook* and, where applicable, the following documents:

- *National Functional Guidelines for Organic Data Review, Multi-Media, Multi-Concentration (OLM01.1) and Low Concentration Water (OLC01.0)* (Environmental Protection Agency Draft 1991b);

- *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses* (Environmental Protection Agency 1988); and

- *National Functional Guidelines for Organic Data Review, Multi-Media, Multi-Concentration (OLM01.0) and Low Concentration Water (OLC01.0), Draft Functional Guidelines for Organics for Pesticide Fractions* (Environmental Protection Agency Draft 1991a).

In addition, data validation procedures or Standard Operating Procedures used by ARI will be reviewed by Tetra Tech, Inc.'s laboratory QA Oversight staff member.

9.3.2.1 Level I Data Reporting. Final reports from ARI will include at least the following elements which are consistent with a Level I data package:

- A copy of the signed Chain-of-Custody form showing the date and time the sample was received;
- A cross-reference of field sample number to laboratory sample number;
- A cross-reference to identify applicable laboratory QC samples with the field sample;
- A glossary to define the symbols and terms used in the laboratory report;
- Sample collection, sample receiving temperature, sample extraction, and analysis dates;
- A list of the instrument and method detection limits;
- Percent moisture content of soil samples;
- A list of practical quantitation limits;
- A sample data or analytical results summary for the samples;
- For GC second column confirmation samples, a data or analytical results summary will also be reported;
- A QA/QC summary report, providing data on method blanks, surrogate recoveries, laboratory control samples, MS/MSD, or any other QA/QC samples relevant to the sample. The QA/QC report will also detail QC limits and discuss corrective actions taken when limits are outside control limits; and
- A case narrative that details a review by ARI of all elements relevant to the sample results as found in Table 9-2, Section D through E for both inorganic and organic analyses.

TABLE 9-2. ARI DATA REQUIREMENTS FOR U.S. AIR FORCE LEVEL II (CLP-EQUIVALENT) DATA PACKAGE
(Page 1 of 2)

I. Organic Analysis

A. Case Narrative
1. Client's name and laboratory identification.
2. Parameters analyzed and method used for each sample.
3. Whether holding times were met or exceeded.
4. Detailed description of all problems encountered.
5. Discussion of possible reasons for any QA/QC criteria outside acceptance criteria.
6. Observations regarding anything that may have affected sample integrity or quality.
7. Data Qualifier definitions.

B. Chain-of-Custody Documentation
1. Legible copies of the Chain-of-Custody forms present with data package.
2. Internal laboratory tracking documents.

C. Environmental Results
1. Client's sample as well as lab sample identification.
2. Sample matrix.
3. Date of sample extraction, as applicable.
4. Date of analysis (time available upon request).
5. Identification of the instrument used.
6. GC Column and detector specification.
7. Weight or volume of sample used for analysis/ extraction.
8. Dilution or concentration factor for the samples.
9. Percentage moisture in soil samples.
10. Method detection limits or sample quantification limits (PQLs).
11. Analytical results.

D. Summary of QA/QC Results
1. Instrument calibration for each instrument used.
   a. Initial Calibration
   b. Daily Calibration/Mid-level Standard.
2. Method Blank Analysis
3. Surrogate Standard Recovery
4. Precision and Accuracy
   a. Matrix spike/matrix spike duplicate analysis; with RPD.
   b. Laboratory duplicate analysis, as applicable; with RPD.
   c. Laboratory QC check sample analysis, with control limits (LCS).
5. Other QC Criteria
   a. Retention time windows determination (GC).
   b. Compound identification-both columns (GC).
   c. Method detection limits determination.
   d. Instrument analysis logs for each instrument used.
   e. IS area counts for GC/MS methods.

Supplemental Data - Deliverable Upon Request

E. Raw Data
1. GC Analysis
   a. Raw data for environmental sample results.
   b. Raw data for the instrument calibrations, both columns.
   c. Raw data for QC analyses, both columns.
   d. Sample extraction and clean-up logs.
   e. Instrument analysis logs for each instrument used.
   f. GC/MS confirmation, as applicable.
2. Raw data for other GC analyses.
   a. Chromatograms with identifiers for all analyte peaks (i.e., retention time).
   b. Area print-outs or quantitation reports.
3. GC/MS Analyses.
   a. Raw data for environmental sample results.
   b. Mass and spectrometer tuning and mass calibration (BFB and DTFPP).
   c. Initial and continuing instrument calibration.
   d. QC analyses.
   e. Sample extraction and clean-up logs.
   f. Instrument analysis logs for each instrument used.
4. Raw data for other GC/MS analyses.
   a. Chromatograms with identifies for all analyte peaks (i.e., retention time).
   b. Enhanced spectra of target analytes.
   c. Quantitation reports.

TABLE 9-2. ARI DATA REQUIREMENTS FOR U.S. AIR FORCE LEVEL II (CLP-EQUIVALENT) DATA PACKAGE
(Page 2 of 2)

Standard Data Deliverable

II. Inorganic Analysis

A. Case Narrative
1. Client's name and laboratory identification.
2. Parameters analyzed and method used for each sample.
3. Whether holding times were met or exceeded.
4. Detailed description of all problems encountered.
5. Discussion of possible reasons for any QA/QC criteria outside acceptance criteria.
6. Observations regarding anything that may have affected sample integrity or quality.

B. Chain-of-Custody Documentation
1. Legible copies of the Chain-of-Custody forms present with data package.
2. Internal laboratory tracking documents present.

C. Environmental Results
1. Client's sample as well as lab sample identification
2. Sample matrix.
3. Date of sample digestion, as applicable.
4. Date of analysis (time available upon request).
5. Identification of the instrument used.
6. Instrument specification.
7. Weight or volume of sample used for analysis/ extraction (in case narrative).
8. Dilution or concentration factor for the samples.
9. Percentage moisture in soil samples.
10. Instrument detection limits or method detection limits or PQL.
11. Definition of any data qualifiers used.
12. Analytical results.

D. Summary of QA/QC Results
1. Instrument calibration for each instrument used.
   a. Initial calibration and verification.
   b. Continuing calibration verification.
2. Method blank analysis for the initial calibration blank.
3. ICP Interference check sample.
4. Precision and Accuracy.
   a. Matrix spike with percent recovery.
   b. Post digest spike with percent recovery (in case narrative) (GFAA).
   c. Laboratory control sample with percent. and control limits.
5. Other QC Criteria
   a. Method of Standard Additions (MSA).
   b. ICP linear ranges.
   c. ICP interlement correction factors.
   d. Detection limits.

Supplemental Data - Deliverable Upon Request

E. Raw Data.
1. Raw data for environmental sample results.
2. Raw data for the instrument calibrations.
3. Raw data for QC analyses.
4. Sample preparation and digestion logs.
5. Instrument analysis logs for each instrument used.
6. Percent moisture in the soil samples.
7. Measurement print-outs and quantitation reports for each instrument used.
8. Absorbance, tritrimetic, or other measurements for wet chemical analysis.

9.3.2.2 Level I Data Review. Level I data review performed by Tetra Tech will consist of an evaluation of the laboratory case narrative and the following:

Holding Times. The elapsed times between collection, extraction, and analysis of samples will be compared to the recommended holding times specified in Table 5-1. All samples deviating from the recommended holding times will be qualified. Professional judgement will be used to evaluate the appropriate qualifications based on the severity of the deviation.

Temperature Blanks. Temperature blanks will accompany each cooler of samples shipped to the laboratory. The temperature of the blanks will be recorded upon arrival at the laboratory. The temperatures will be compared to the recommended preservation temperatures specified in Table 5-1. If the temperatures deviate from the recommended preservation temperatures, professional judgement will be used to determine if the deviation warrants qualification of the data.

Second Column Confirmation. The analyses requiring second column confirmation will be evaluated to confirm the presence of a detected analyte. Those analytes that cannot be confirmed in the second column will be qualified.

Relative Percent Difference. RPDs will be compared between field duplicate samples and replicate samples. When occasional RPDs are greater than 40 percent for soil or 30 percent for water, Tetra Tech, Inc. will attempt to assess if the source of the discrepancy can be ascribed to sample heterogeneity or some other natural cause. If RPDs consistently exceed control limits at any point during the project, sampling or analytical procedures will be reevaluated.

Laboratory and Field Blanks. Results of laboratory and field blank analysis will be reviewed for the presence of contaminants. Corrective actions shall be implemented whenever laboratory blank and field blank contamination is detected. Data qualifiers are further explained below.

Matrix Spike/Matrix Spike Duplicate or Duplicate. MS/MSD or duplicate sample data will be reviewed for consistency and compliance with set control limits. In instances where MS/MSD or duplicate results exceed control limits, nonconformance reports will be reviewed by the data validation staff to assess the possible reasons for the exceedance. In the case of second column confirmation results, a second column MS/MSD or duplicate QC sample will also be analyzed and the results will be included in the final report. Those data will also be reviewed by the data reviewing staff. The second column confirmation sample will also be reviewed for compliance with holding time requirements.

Laboratory Control Samples. Laboratory Control Samples (LCS) will be reviewed for consistency and compliance with set control limits. As with the matrix QC samples, when the laboratory control sample results exceed control limits, corrective action reports will be reviewed by the data reviewing staff to assess the possible reasons.

Surrogate Spikes. In all samples associated with organic analysis, surrogates will be spiked at a specific concentration. During the data review, surrogate concentrations will be reviewed against control limits provided in Section 10.0 of this document. Organic data results will also be evaluated by surrogate recoveries.

9.3.2.3 Data Review Qualifiers and Descriptors. The following qualifiers and descriptors will be used as coefficients to describe data that fail criteria during a Level I review:

U The analyte was analyzed for, but was not reported above the method detection limit (MDL).

J The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample. This qualifier is used when the result is between the practical quantitation limit (PQL) and MDL.

UJ The analyte was not reported above the method detection limit. However, the practical quantitation limit is approximate and may or may not represent the actual limit necessary to accurately and precisely measure the analyte in the sample.

B The environmental sample result is less than five times or ten times (for common laboratory contaminants) the blank contamination.

"B" Used in inorganics (metals) to indicate sample or blank detected above MDL but below PQL.

R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

The following descriptors will be used for any situation where qualification was deemed necessary:

a	Analyte was found in the method blank.
b	Surrogate spike outside control limits.
c	Matrix spike/matrix spike duplicate outside control limits.
d	Laboratory control sample outside control limits.
e	Holding time violation occurred.
f	Laboratory duplicate sample failed precision criteria.
g	The data met prescribed criteria as detailed in the appropriate QAPP.
h	Second column results indicate that the environmental results were not confirmed.
k	The analyte was found in the field blank.
n	Laboratory case narrative related issue(s).
t	Temperature blank outside acceptance criteria.

9.3.2.4 Level II Data Reporting and Validation. After reviewing the data packages, the Tetra Tech Project Manager will request from ARI that 10 percent of the data packages be submitted in a U.S. Air Force Level II (Contract Laboratory Program (CLP)-equivalent) format, whose contents are listed in Table 9-2. These packages will be validated by a third-party validator.

9.4 DATA REPORTING

Data generated during the RI/FS work effort at Kotzebue LRRS will be incorporated into the IRPIMS database program. The most recent Contractor Data Loading Tool (CDLT) and QC Tool Program will be used for the IRPIMS deliverable in conjunction with Tetra Tech, Inc.'s SOP derived for this task.

This SOP includes instructions regarding data review for consistency and status, maintenance of magnetically stored data to ensure integrity, plus the internal review process for the IRPIMS deliverable. The final IRPIMS deliverable to the U.S. Air Force will be analyzed by the QC Tools Program to verify that the deliverable is 100 percent error free.

All data gathered during the work effort at Kotzebue LRRS will be detailed into appropriate Analytical Data Informal Technical Information Reports (ITIR). The Analytical Data ITIR will contain all relevant portions as detailed in the *Handbook*. Additionally, all data will be reviewed using Tetra Tech, Inc.'s SOP specific to that task. The resulting reviewed and, if appropriate, qualified data will be provided in the Analytical Data ITIR.

9.5 DATA MANAGEMENT

Tetra Tech, Inc. will exert control over all aspects of data gathering during the RI/FS work efforts at Kotzebue LRRS. This will help to ensure that the DQOs specified in the Work Plan for Kotzebue LRRS are achieved. Figure 9-2 illustrates how Tetra Tech, Inc. will manage the data collected from both field operations and laboratory-generated results.

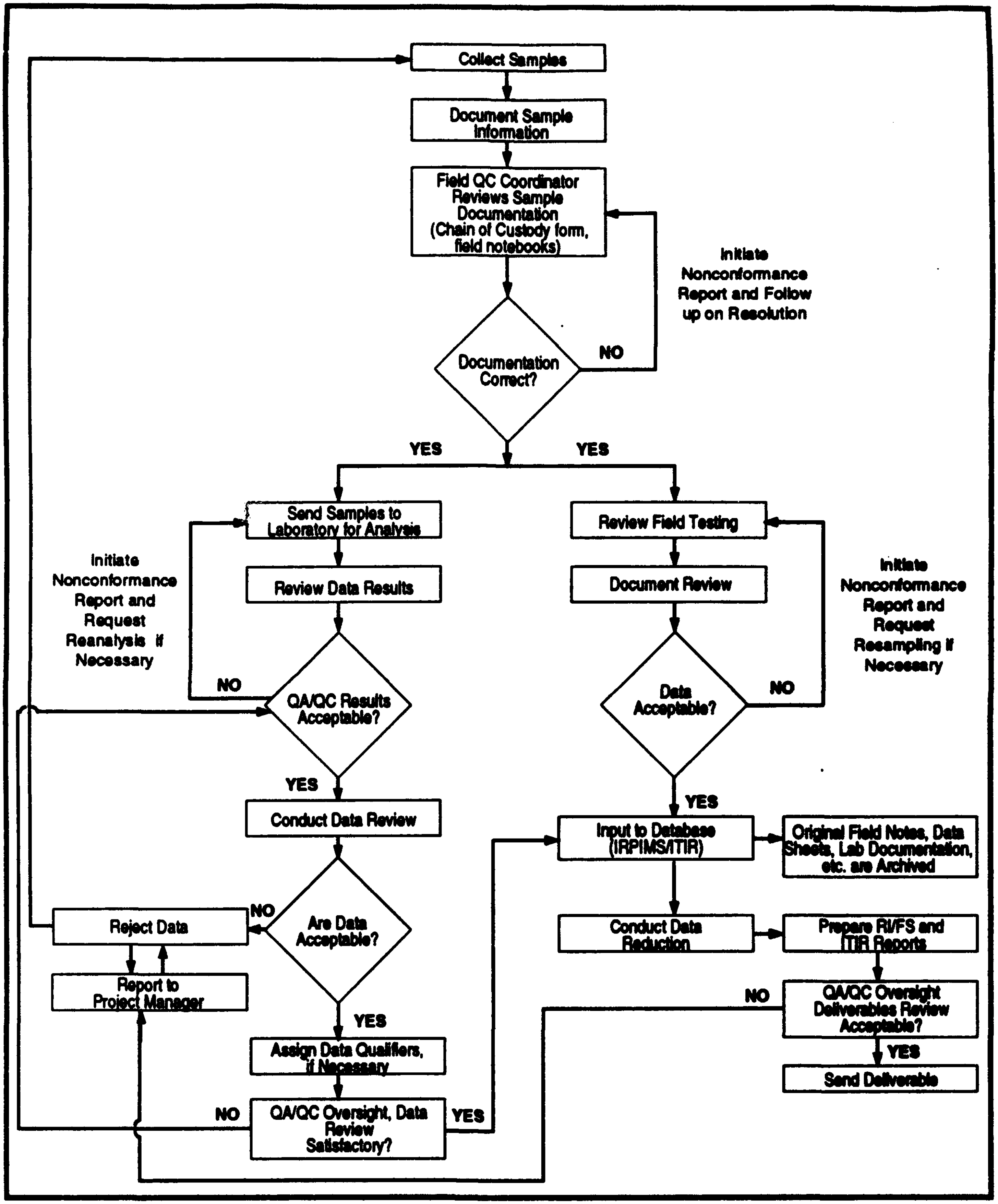

Figure 9-2. Data Management Flowchart

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10.0 INTERNAL QUALITY CONTROL CHECKS

Sample collection procedures are provided in greater detail specific to the work effort at Kotzebue LRRS in the FSP of this document. QC procedures associated with all sample collection procedures are an integral part of each sampling methodology. These procedures will be oriented to the collection of representative samples that are free of external contamination.

10.1 FIELD ACTIVITIES QUALITY CONTROL

The following details field QA/QC procedures to be used during sample collection at Kotzebue LRRS:

- One trip blank will accompany every cooler shipment of environmental samples sent to the analytical laboratory for analysis of volatile organic compounds.

- One temperature blank will accompany every ice chest containing soil and water samples sent to the laboratory for chemical analysis.

- Ambient condition blanks are a type of field blank which are prepared by pouring Reagent Grade Type II water into sample containers at a sampling site. These blanks are handled as samples and then sent to the laboratory for analysis. Ambient condition blanks will be collected at a 10 percent sample (VOC sample) frequency or one ambient condition blank will be collected for every volatile organic compound sampling event (whichever is fewer). Ambient condition blanks are analyzed for volatile organic compounds using EPA Method 8260.

- Equipment blank samples will be collected daily from sampling equipment used to collect 10 or more field samples. If less than 10 samples are collected within a day, equipment blanks will be collected based on a running cumulative total at a 10 percent frequency. All parameters noted on the Chain-of-Custody form for that sampling event will be analyzed for the equipment blank.

- Duplicate water samples will be collected at a frequency of 10 percent to provide a measure of possible sampling method variability. The duplicate samples will consist of two samples collected independently at one sampling location during one act of sampling.

- Replicate soil samples will be collected at a frequency of 10 percent to provide a measure of method variability or precision. The replicates will consist of two sequential sample containers from the field sample.

- Chain-of-Custody forms will accompany all samples.

- Sampling apparatus will be thoroughly cleaned between each sampling event to prevent cross-contamination of the samples. Details for decontamination procedures for drilling and sampling equipment are provided in Sections 3.1.9 of the FSP.

10.2 LABORATORY ANALYSIS QUALITY CONTROL

As the result of a preliminary screen for environmental samples which contain a high level of contamination or interference, ARI will analyze the samples on a reduced volume or amount of extracted material for analysis. The spiking level for these analyses can be found in the appropriate SOP in Volume II, Appendix B of the QAPP. For SW 3550 level analysis, the relevant quality control parameters to be used by ARI can be found in the following sections.

10.2.1 Laboratory or Method Blank

ARI will use an artificial, matrixless sample to monitor the analytical batch for interferences and contamination from glassware, reagents, and other potential laboratory-generated contaminants. An analytical batch will be those samples that are grouped together with the same method sequence and the same reagent lot and process common to each sample within the same period or in the continuous sequential time periods. The laboratory blank is taken through the entire sample preparation process, and is included with each batch of extractions/digestion preparation or with each 20 samples, whichever is more frequent.

10.2.2 Laboratory Control Sample

The Laboratory Control Samples (LCS) are defined as blank soil or reagent water spiked with a known amount of analyte. The spiking analyte is from a different source than that used to establish the calibration standards. Table 10-1 details the control limits for laboratory control samples for the analytical method to be used by ARI on samples collected during the RI/FS investigation at Kotzebue LRRS. In addition, for metal and total organic carbon analyses of soil samples, ARI will use a certified reference material. As the vendor lot changes, the certificate of traceability plus second source verification will be included with each applicable data deliverable.

TABLE 10-1. ARI CONTROL LIMITS FOR LABORATORY CONTROL SAMPLES AND SURROGATE SPIKES
(Page 1 of 4)

		Spike Concentration		Laboratory-Established Control Limits Percent Recovery %		
Analytical Method	Spiking Compounds	Water (mg/L)	Soil/Sediments (mg/kg)	Water	Soil/Sediments	
6010	Antimony	2.5	250	±20[b]	±20[b]	
	Barium	2.0	200	±20[b]	±20	
	Beryllium	0.05	5.0	±20[b]	±20[b]	
	Cadmium	0.1	10	±20[b]	±20[b]	
	Calcium	10	1,000	±20[b]	±20[b]	
	Chromium	0.25	25	±20[b]	±20[b]	
	Cobalt	0.25	25	±20[b]	±20[b]	
	Copper	0.1	10	±20[b]	±20[b]	
	Molybdenum	0.25	25	±20[b]	±20[b]	
	Nickel	0.50	50	±20[b]	±20[b]	
	Silica	5.0	NA[a]	±20[b]	NA[b]	
	Silver	0.25	25	±20[b]	±20[b]	
	Vanadium	0.10	10	±20[b]	±20[b]	
	Zinc	0.50	50	±20[b]	±20[b]	
	Aluminum	2.5	250	±20[b]	±20[b]	
	Iron	2.5	250	±20[b]	±20[b]	
	Manganese	0.5	50	±20[b]	±20[b]	
	Magnesium	10.0	1,000	±20[b]	±20[b]	
	Potassium	10.0	1,000	±20[b]	±20[b]	
	Sodium	10.0	1,000	±20[b]	±20[b]	
	Thallium	2.5	250	±20[b]	±20[b]	
7421 Modified	Lead	0.1	10	±20[b]	±20[b]	
7470	Mercury	0.001	NA[a]	±20[b]	NA[a]	
7471	Mercury	NA[a]	0.5	NA	±20[b]	

TABLE 10-1. ARI CONTROL LIMITS FOR LABORATORY CONTROL SAMPLES AND SURROGATE SPIKES
(Page 2 of 4)

		Spike Concentration		Laboratory-Established Control Limits Percent Recovery %		
Analytical Method	Spiking Compounds	Water (μg/L)	Soil/Sediments (mg/kg)	Water	Soil/Sediments	
8081	**Analyte:**					
	Lindane (-BHC)	0.50	0.017	39-144[b]	37-142[b]	
	Heptachlor	0.50	0.017	35-109[b]	43-124[b]	
	Aldrin	0.50	0.017	39-109[b]	40-120[b]	
	Dieldrin	1.0	0.033	53-145[b]	44-133[b]	
	Endrin	1.0	0.033	45-136[b]	38-139[b]	
	4,4'-DDT	1.0	0.033	55-142[b]	47-135[b]	
	PCB, Aroclor 1260	10	0.33	55-142[b]	49-135[b]	
	Delta BHC	0.50	0.017	35-120[b]	35-120[b]	
	4,4'-DDE	1.0	0.033	55-142[b]	49-135[b]	
	4,4'-DDD	1.0	0.033	55-142[b]	49-135[b]	
	Surrogate:					
	TCX	0.2	0.0067	30-102[b]	37-114[b]	
	DCBP	0.2	0.0067	30-135[b]	40-127[b]	
8260	**Analyte:**					
	1,1-Dichloroethene	50	0.050	71-147[b]	71-147[b]	
	Trichloroethene	50	0.050	82-138[b]	82-138[b]	
	Benzene	50	0.050	79-147[b]	79-147[b]	
	Toluene	50	0.050	87-140[b]	87-140[b]	
	Chlorobenzene	50	0.050	87-145[b]	87-145[b]	
	Bromochloromethane	50	0.050	60-125[b]	60-125[b]	
	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	50	0.050	60-125[b]	60-125[b]	
	Ethylbenzene	50	0.050	60-125[b]	60-125[b]	
	Xylene (Total)	50	0.050	60-125[b]	60-125[b]	
	Surrogate:					
	Toluene-d_8	50	0.050	66-138[b]	87-113[b]	
	Bromofluorobenzene	50	0.050	63-131[b]	72-121[b]	
	1,2-Dichloroethane-d_4	50	0.050	62-139[b]	86-136[b]	

TABLE 10-1. ARI CONTROL LIMITS FOR LABORATORY CONTROL SAMPLES AND SURROGATE SPIKES
(Page 3 of 4)

		Spike Concentration		Laboratory-Established Control Limits Percent Recovery %		
Analytical Method	Spiking Compounds	Water (μg/L)	Soil/Sediments (mg/kg)	Water	Soil/Sediments	
8270	Analyte:	SW3510/SW3520		SW3510		SW3520 (water)
	Phenol	37.5	2.5	10-100[b]	37-104[b]	10-100[b]
	2-Chlorophenol	37.5	2.5	41-107[b]	45-108[b]	41-107[b]
	1,4-Dichlorobenzene	25	1.67	37-100[b]	38-105[b]	37-100[b]
	N-nitroso-di-n-propylamine	25	1.67	41-103[b]	38-107[b]	41-103[b]
	1,2,4-Trichlorobenzene	25	1.67	10-103[b]	35-113[b]	10-103[b]
	4-Chloro-3-Methylphenol	37.5	2.5	41-104[b]	34-111[b]	41-104[b]
	Acenaphthene	25	1.67	44-107[b]	41-113[b]	44-107[b]
	4-Nitrophenol	37.5	2.5	10-100[b]	11-124[b]	10-100[b]
	2,4-Dinitrotoluene	25	1.67	37-101[b]	33-106[b]	37-101[b]
	Pentachlorophenol	37.5	2.5	10-130[b]	10-128[b]	10-130[b]
	Pyrene	25	1.67	42-130[b]	39-128[b]	42-130[b]
	2-Methylnaphthalene	25	1.67	47-145[b]	47-145[b]	28-114[b]
	Surrogates:					
	Nitrobenzene-d_5	25	1.67	35-110[b]	29-117[b]	35-110[b]
	2-Fluorobiphenyl	25	1.67	43-104[b]	33-114[b]	43-104[b]
	Terphenyl-d_{14}	25	1.67	33-133[b]	28-133[b]	33-133[b]
	Phenol-d_5	37.5	2.5	10-100[b]	40-104[b]	10-100[b]
	2-Fluorophenol	37.5	2.5	21-110[b]	36-111[b]	21-110[b]
	2,4,6-Tribromophenol	37.5	2.5	16-122[b]	24-122[b]	16-122[b]
	2-Chlorophenol-d_4	37.5	2.5	33-102[b]	43-102[b]	33-102[b]
	1,2-Dichlorobenzene-d_4	25	1.67	28-105[b]	24-112[b]	28-105[b]

TABLE 10-1. ARI CONTROL LIMITS FOR LABORATORY CONTROL SAMPLES AND SURROGATE SPIKES
(Page 4 of 4)

		Spike Concentration		Laboratory-Established Control Limits Percent Recovery %		
Analytical Method	Spiking Compounds	Water (mg/L)	Soil/Sediments (mg/kg)	Water	Soil/Sediments	
9060 Modified	TOC	20	*	±20[b]	±20[b]	
AK101/AK102	Gasoline	2.5	250	89-111	79-112	
	Diesel	1.5	100	60-120	60-120	
	Surrogates:					
	Trifluorotoluene	0.050	5.0	79-110[b]	80-112[b]	
	Bromobenzene	0.025	2.5	70-117[b]	73-117[b]	
	Methyl arachidate	0.075	3.0	52-138	50-150	
8150 TCLP	2,4-D	0.05	NA	30-143	NA	
	Silvex	0.0125	NA	30-143	NA	
	Surrogates:					
	2,4-Dichlorophenylacetic acid	0.0625	NA	38-132	NA	

[a] NA - Not applicable.

[b] Interim limit. Statistical limits will be established on generation of 20 data points.

[c] This analyte is very difficult to monitor, and is unstable in water.

* TOC Soil LCS - NBS 2704 (3.35%C).

10.2.3 Control Limits for Matrix Spike/Matrix Spike Duplicates, and Surrogate Spikes

For both organic and inorganic analyses, MS/MSD QC samples will be used in each batch with a frequency of 5 percent or with each different type of sample matrix, whichever is more frequent. Spiked sample results that exceed the control limits described in Table 10-2 will be further evaluated under the laboratory data review procedure described in this QAPP. The matrix spiking solutions for organics are prepared from neat materials, or from sources independent of the calibrations standards. Inorganic MS/MSDs are prepared with analytes of interest at an appropriate concentration as specified in SW-846. The specific MS/MSD analytes for organic QC samples are shown in Table 10-2 for ARI. The analytes for inorganic MS/MSD QC samples are also detailed in Table 10-2.

10.2.4 Surrogate Compounds

For GC and GC/MS analyses, the analytical process includes the addition, subsequent detection, and recovery calculations of surrogate spiking compounds. Surrogate compounds are added to every sample at the beginning of the sample preparation, and the surrogate recovery is used to monitor matrix effects and sample preparation. Method-specific surrogates are used in both matrix and laboratory control samples to establish the possibility of matrix interference. Suitable surrogates will have the following qualities:

- Will be compounds not requested for analysis;
- Are compounds that do not interfere with the determination of the analytes of interest;
- Are not naturally occurring, but are chemically similar to the analytes of interest; and
- Exhibit similar responses to the analytes of interest.

Tables 10-1 and 10-2 detail the control limits for surrogate spiking compounds to be used by ARI in both laboratory control and matrix spike/matrix spike duplicate samples. A summary of internal QC procedures to be used by ARI are provided in Table 10-3.

For each vendor or lot, ARI will compare from historic methods response factors, retention times, relative retention times, for any previous established surrogates. For GC/MS, spectral confirmation will also take place by automated quantitation which use purity and fit parameters for identifying compounds. Additionally, for any new surrogate compounds not previously run for a method, ARI will determine either by second source analysis or a mass spectroscopic scan that the commercially available surrogate is as represented in this document and as detailed on the vendor's certificate of traceability.

10.2.5 Interlaboratory Duplicate Samples

10 percent soil and water samples will be collected and forwarded to an additional laboratory. These samples will be analyzed by the same test methods as requested of ARI. An acceptance criteria of ± 10 percent will be used to evaluate the sample analyzed by ARI and its duplicate analyzed by an additional laboratory. This is part of Tetra Tech, Inc's Quality Assurance Program to provide interlaboratory comparison of analytical data collected during the Kotzebue LRRS work effort.

TABLE 10-2. ARI CONTROL LIMITS FOR MATRIX SPIKES, MATRIX SPIKE DUPLICATES, AND SURROGATE SPIKES
(Page 1 of 4)

Analytical Method	Spiking Compounds	Spike Concentration		Laboratory-Established Control Limits			
				Percent Recovery %		Relative Percent Difference (%)	
		Water (mg/L)	Soil/Sediments (mg/kg)	Water	Soil/Sediments	Water	Soil/Sediments
7421 Modified	Lead	0.1	10	75-125[b]	75-125[b]	20[b]	20[b]
7470	Mercury	0.001	NA	75-125[b]	75-125[b]	20[b]	20[b]
7471	Mercury	NA[a]	0.5	75-125[b]	75-125[b]	20[b]	20[b]
6010	Antimony	2.5	250	75-125[b]	75-125[b]	20[b]	20[b]
	Barium	2.0	200	75-125[b]	75-125[b]	20[b]	20[b]
	Beryllium	0.05	5	75-125[b]	75-125[b]	20[b]	20[b]
	Cadmium	0.1	10	75-125[b]	75-125[b]	20[b]	20[b]
	Calcium	10	1,000	75-125[b]	75-125[b]	20[b]	20[b]
	Chromium	0.25	25	75-125[b]	75-125[b]	20[b]	20[b]
	Cobalt	0.25	25	75-125[b]	75-125[b]	20[b]	20[b]
	Copper	0.1	10	75-125[b]	75-125[b]	20[b]	20[b]
	Molybdenum	0.25	25	75-125[b]	75-125[b]	20[b]	20[b]
	Nickel	0.50	50	75-125[b]	75-125[b]	20[b]	20[b]
	Silica	5.0	NA	75-125[b]	NA	20[b]	NA
	Silver	0.25	25	75-125[b]	75-125[b]	20[b]	20[b]
	Thallium	2.5	250	75-125[b]	75-125[b]	20[b]	20[b]
	Vanadium	0.10	10	75-125[b]	75-125[b]	20[b]	20[b]
	Zinc	0.5	50	75-125[b]	75-125[b]	20[b]	20[b]
	Aluminum	2.5	250	75-125[b]	75-125[b]	20[b]	20[b]
	Iron	2.5	250	75-125[b]	75-125[b]	20[b]	20[b]
	Manganese	0.5	50	75-125[b]	75-125[b]	20[b]	20[b]
	Magnesium	10	1,000	75-125[b]	75-125[b]	20[b]	20[b]
	Potassium	10	1,000	75-125[b]	75-125[b]	20[b]	20[b]
	Sodium	10	1,000	75-125[b]	75-125[b]	20[b]	20[b]

TABLE 10-2. ARI CONTROL LIMITS FOR MATRIX SPIKES, MATRIX SPIKE DUPLICATES, AND SURROGATE SPIKES
(Page 2 of 4)

Analytical Method	Spiking Compounds	Spike Concentration		Laboratory-Established Control Limits			
				Percent Recovery %		Relative Percent Difference (%)	
		Water (mg/L)	Soil/Sediments (mg/kg)	Water	Soil/Sediments	Water	Soil/Sediments
AK101/AK102	Gasoline	2.5	250	60-120[b]	60-120[b]	20[b]	20[b]
	Diesel	1.5	100	60-120[b]	60-120[b]	20[b]	20[b]
	Surrogates:						
	Methyl arachidate	0.075	3.0	32-157[b]	33-160[b]	20[b]	20[b]
	Trifluorotoluene	0.050	5.0	76-111[b]	50-150[b]	20[b]	20[b]
	Bromobenzene	0.025	2.5	71-121[b]	50-150[b]	20[b]	20[b]
8150 TCLP	2,4-D	0.05	NA	30-146	NA	30[b]	NA
	Silvex	0.0125	NA	30-144	NA	30[b]	NA
	Surrogates:						
	2,4-Dichlorophenylacetic acid	0.0625	NA	52-143	NA	30[b]	NA

TABLE 10-2. ARI CONTROL LIMITS FOR MATRIX SPIKES, MATRIX SPIKE DUPLICATES, AND SURROGATE SPIKES
(Page 3 of 4)

Analytical Method	Spiking Compounds	Spike Concentration		Laboratory-Established Control Limits			
				Percent Recovery %		Relative Percent Difference (%)	
		Water (μg/L)	Soil/Sediments (mg/kg)	Water	Soil/Sediments	Water	Soil/Sediments
8081	**Matrix:**						
	Lindane (-BHC)	0.5	0.017	40-140[b]	37-142[b]	27[b]	37[b]
	Heptachlor	0.5	0.017	35-110[b]	43-124[b]	47[b]	29[b]
	Aldrin	0.5	0.017	35-110[b]	40-120[b]	65[b]	41[b]
	Dieldrin	1.0	0.033	53-145[b]	44-133[b]	23[b]	34[b]
	Endrin	1.0	0.033	45-136[b]	38-139[b]	31[b]	58[b]
	4,4'-DDT	1.0	0.033	55-142[b]	49-135[b]	34[b]	33[b]
	PCB, Aroclor 1260	10	0.33	55-142[b]	49-135[b]	34[b]	33[b]
	Delta, BHC	0.50	0.017	35-120[b]	35-120[b]	49[b]	43[b]
	4,4'-DDE	1.0	0.033	55-142[b]	49-135[b]	34[b]	33[b]
	4,4'-DDD	1.0	0.033	55-142[b]	49-135[b]	34[b]	33[b]
	Surrogate:						
	TCX	0.2	0.0067	41-121[b]	46-131[b]		
	DCBP	0.2	0.0067	45-139[b]	54-138[b]		
8260	**Matrix:**						
	1,1-Dichloroethene	50	0.050	37-117[b]	32-144[b]	31[b]	54[b]
	Trichloroethene	50	0.050	60-125[b]	76-117[b]	40[b]	19[b]
	Benzene	50	0.050	60-115[b]	72-128[b]	29[b]	17[b]
	Toluene	50	0.050	62-125[b]	79-120[b]	43[b]	16[b]
	Chlorobenzene	50	0.050	59-126[b]	78-122[b]	45[b]	17[b]
	Chlorobromomethane	50	0.050	60-125[b]	60-125[b]	30[b]	20[b]
	1,1,2-Trichloro-1,2,2-tri-fluoroethane (Freon 113)	50	0.050	60-125[b]	60-125[b]	30[b]	20[b]
	Ethylbenzene	50	0.050	60-125[b]	60-125[b]	30[b]	20[b]
	Xylene (Total)	50	0.050	60-125[b]	60-125[b]	30[b]	20[b]
	Surrogates:						
	Toluene-d_8	50	0.050	94-109[b]	87-112[b]		
	Bromofluorobenzene	50	0.050	88-119[b]	47-130[b]		
	1,2-Dichloroethane-d_4	50	0.050	92-121[b]	88-126[b]		

TABLE 10-2. ARI CONTROL LIMITS FOR MATRIX SPIKES, MATRIX SPIKE DUPLICATES, AND SURROGATE SPIKES
(Page 4 of 4)

Analytical Method	Spiking Compounds	Spike Concentration		Laboratory-Established Control Limits			
				Percent Recovery %		Relative Percent Difference (%)	
		Water (µg/L)	Soil/Sediments (mg/kg)	Water	Soil/Sediments	Water	Soil/Sediments
8270	**Matrix:**						
	Phenol	37.5	2.5	5-112[b]	5-112[b]	55[b]	12[b]
	2-Chlorophenol	37.5	2.5	23-134[b]	23-134[b]	42[b]	11[b]
	1,4-Dichlorobenzene	25	1.67	20-124[b]	20-124[b]	27[b]	24[b]
	n-Nitroso-di-n-propylamine	25	1.67	10-230[b]	10-230[b]	32[b]	21[b]
	1,2,4-Trichlorobenzene	25	1.67	44-142[b]	44-142[b]	26[b]	16[b]
	4-Chloro-3-Methylphenol	37.5	2.5	22-147[b]	22-147[b]	53[b]	17[b]
	Acenaphthene	25	1.67	47-145[b]	47-145[b]	21[b]	19[b]
	4-Nitrophenol	37.5	2.5	10-132[b]	10-132[b]	42[b]	77[b]
	2,4-Dinitrotoluene	25	1.67	39-139[b]	39-139[b]	21[b]	55[b]
	Pentachlorophenol	37.5	2.5	14-176[b]	14-176[b]	33[b]	50[b]
	Pyrene	25	1.67	52-115[b]	52-115[b]	21[b]	83[b]
	2-Methylnaphthalene	25	1.67	47-145[b]	47-145[b]	21[b]	19[b]
	Surrogates:						
	Nitrobenzene-d_5	25	1.67	35-110[b]	29-117[b]		
	2-Fluorobiphenyl	25	1.67	43-104[b]	33-114[b]		
	Terphenyl-d_{14}	25	1.67	33-133[b]	28-133[b]		
	Phenol-d_5	37.5	2.5	10-100[b]	40-104[b]		
	2-Fluorophenol	37.5	2.5	21-110[b]	36-111[b]		
	2,4,6-Tribromophenol	37.5	2.5	16-122[b]	24-122[b]		
	2-Chlorophenol-d_4	37.5	2.5	33-102[b]	43-102[b]		
	1,2-Dichlorobenzene-d_4	25	1.67	28-105[b]	24-112[b]		
9060	Total Organic Carbon	20 mg/L	20,000[d]	75-125[b]	75-125[b]	20[b]	20[b]

[a] NA = Not applicable.

[b] Interim limit. Statistical limit will be established on generation of a minimum of 20 data points.

[c] Interim values will be established and forwarded upon completion.

[d] Spiking levels dependent on native concentration of TOC. It is common to encounter solid environmental samples of greater than 1% (10,000 mg/kg) TOC.

TABLE 10-3. SUMMARY OF INTERNAL QUALITY CONTROL PROCEDURES ARI
(Page 1 of 6)

Method	Parameter	QC Performed	Frequency[a]	Acceptance Criteria	Corrective Action
6010 (ICP)	Metals	**Field**			
		Equipment blanks	1 each day of water sampling	≤ 3 x MDL	No laboratory corrective action required
		Duplicate field sample	10%	RPD ≤ 30% (W) RPD ≤ 40% (S)	No laboratory corrective action required
		Laboratory			
		Method blank	5%	≤ 3 x MDL	Find source of contamination and reanalyze all associated samples
		Laboratory control sample	5%	See Table 10-1	Reanalyze all associated samples; if necessary
		Matrix spike sample	5%	See Table 10-2	Flag matrix spike recoveries as attributable to matrix effects
		Matrix spike duplicate sample	5%	See Table 10-2	Same as matrix spike
		ICP interference check	Run at beginning and end of daily run	80-120% of true value	1) Repeat calibration 2) See Inorganics Supervisor
		Serial dilution analysis 5X as required in method (unusual matrix)	5%	%D ≤10% if original sample concentration exceeds MDL by a factor of 50	Flag data
7421	Pb	**Field**			
		Equipment blanks	1 each day of water sampling	≤ 3 x MDL	No laboratory corrective action required
		Duplicate field sample	10%	RPD ≤ 30% (W) RPD ≤ 40% (S)	No laboratory corrective action required
		Laboratory			
		Method blank	5%	≤ 3 x MDL	Find source of contamination and reanalyze all associated samples
		Laboratory control sample	5%	See Table 10-1	Reanalyze all associated samples; if necessary
		Matrix spike sample	5%	See Table 10-2	Flag matrix spike recoveries as attributable to matrix effects
		Matrix spike duplicate sample	5%	See Table 10-2	Flag matrix spike recoveries as attributable to matrix effects

TABLE 10-3. SUMMARY OF INTERNAL QUALITY CONTROL PROCEDURES ARI
(Page 2 of 6)

Method	Parameter	QC Performed	Frequency[a]	Acceptance Criteria	Corrective Action
7421 (Cont.)	Pb (Cont.)	Analytical spikes	all samples if required	85-115%	Dilute sample and rerun if still out of control, perform MSA
		Method of Standard Addition	if required	$r \geq 0.995$	Repeat once, if $r < 0.995$, report result of MSA with better correlation coefficient
7470/7471	Hg	**Field**			
		Equipment blanks	1 each day of water sampling	≤ 3 x MDL	No laboratory corrective action required
		Duplicate Field Sample	10%	RPD ≤ 30% (W) RPD ≤ 40% (S)	No laboratory corrective action required
		Laboratory			
		Method blank	5%	≤ 3 x MDL	Find source of contamination and reanalyze all associated samples
		Laboratory control sample	5%	See Table 10-1	Reanalyze all associated samples; if necessary
		Matrix spike	5%	See Table 10-2	Flag matrix spike recoveries as attributable to matrix effects
		Matrix spike duplicate	5%	See Table 10-2	Flag matrix spike recoveries and reanalyze if necessary
AK101 and AK102 (GC/FID)	Gasoline and Diesel Range TPH	**Field**			
		Equipment blank	1 each day of water sampling	≤ 3 x MDL	No laboratory corrective action required
		Trip blank (volatile analyses only)	1 per shipment	≤ 3 x MDL	No laboratory corrective action required
		Duplicate field sample	10%	RPD ≤ 30% (W) RPD ≤ 40% (S)	No laboratory corrective action required
		Ambient condition blank (volatile analyses only)	1 each day of water sampling	≤ 3 x MDL	No laboratory corrective action required
		Laboratory			
		Method blank	1 per batch	≤ 3 x MDL	1) Evaluate system; run system blank, or 2) Reanalyze, or 3) Reextract/reanalyze if necessary

TABLE 10-3. SUMMARY OF INTERNAL QUALITY CONTROL PROCEDURES ARI
(Page 3 of 6)

Method	Parameter	QC Performed	Frequency[a]	Acceptance Criteria	Corrective Action
AK101 and AK102 (GC/FID) (Cont.)	Gasoline and Diesel Range TPH (Cont.)	Laboratory control sample	5%	See Table 10-1	1) Assess impact on data, or 2) Reanalyze, if necessary, or 3) Recalibrate, or 4) Reanalyze any affected samples, if necessary
		Matrix spike sample	5%	See Table 10-2	1) Evaluate system 2) Check calculations 3) Check LCS; if recoveries within limits, flag MS recoveries as attributable to matrix effects
		Matrix spike duplicate sample	5%	See Table 10-2	Same as MS
		Surrogate spikes	Every sample, method blank, and QC Sample	See Table 10-2	1) Check calculations 2) Check laboratory control sample 3) Reanalyze; if recoveries within limits, flag sample recoveries as attributable to matrix effects 4) If still out of control, flag associated sample
8081 (GC/ECD)	Organochlorine Pesticide and PCBs	**Field** Equipment blank	1 each day of water sampling	$\leq$ 3 x MDL	No laboratory corrective action required
8150/TCLP[b] (GC/ECD)	Organochlorine Herbicides	Duplicate field sample	10%	RPD $\leq$ 30% (W) RPD $\leq$ 40%	No laboratory corrective action required
		Laboratory Method blank	1 per batch	$\leq$ 3 x MDL	1) Evaluate system: run system blank, or 2) Reanalyze, or 3) Reextract/reanalyze if necessary
		Laboratory control sample	5%	See Table 10-1	1) Check calculations, or 2) Rerun, or 3) Reprepare and/or reanalyze method blank and all samples associated with it if appropriate
		Matrix spike sample	5%	See Table 10-2	1) Evaluate system 2) Check calculations 3) Check LCS; if recoveries within limits, flag matrix spike recoveries as attributable to matrix effects

TABLE 10-3. SUMMARY OF INTERNAL QUALITY CONTROL PROCEDURES ARI
(Page 4 of 6)

Method	Parameter	QC Performed	Frequency[a]	Acceptance Criteria	Corrective Action
8081 (GC/ECD) (Cont.)	Organochlorine Pesticide and PCBs (Cont.)	Matrix spike duplicate sample	5%	See Table 10-2	Same as matrix spike
8150/TCLP[b] (GC/ECD) (Cont.)	Organochlorine Herbicides (Cont.)	Surrogate spikes	Every sample, method blank, and QC sample	See Table 10-2	1) Check calculations 2) Check laboratory control sample 3) Reanalyze; if recoveries within limits, flag sample recoveries as attributable to matrix effects 4) If still out of control, flag associated sample
8260 (GC/MS) (Cap. col.)	Volatile Organics	Field Equipment blanks	1 each day of water sampling	$\leq$ 3 x MDL	No laboratory corrective action required
		Trip blank	1 per shipment	$\leq$ 3 x MDL	No laboratory corrective action required
		Duplicate field sample	10%	RPD $\leq$ 30% (W) RPD $\leq$ 40% (S)	No laboratory corrective action required
		Ambient condition blank	1 each day of water sampling	$\leq$ 3 x MDL	No laboratory corrective action required
		Laboratory Method blank	1 per batch	$\leq$ MDL except for common laboratory contaminants which may be 3 x MDL	1) Evaluate system; run system blank, or 2) Reanalyze, or 3) Reextract/reanalyze if necessary
		Laboratory control sample	5%	See Table 10-1	1) Check calculations, or 2) Rerun, or 3) Reprepare and/or reanalyze method blank and all samples associated with it if appropriate
		Matrix spike	5%	See Table 10-2	1) Evaluate system 2) Check calculations 3) Check laboratory control sample; if recoveries not within limits, flag matrix spike recoveries as attributable to matrix effects

TABLE 10-3. SUMMARY OF INTERNAL QUALITY CONTROL PROCEDURES ARI
(Page 5 of 6)

Method	Parameter	QC Performed	Frequency[a]	Acceptance Criteria	Corrective Action
8260 (GC/MS) (Cap. col.) (Cont).	Volatile Organics (Cont.)	Matrix spike duplicate	5%	See Table 10-2	1) Check calculations 2) Check laboratory control sample; if recoveries not within limits, flag matrix spike recoveries as attributable to matrix effects
		Surrogate spikes	Every sample, method blank, and QC sample	See Table 10-2	1) Check calculations 2) Check laboratory control sample 3) Reanalyze; if recoveries are within limits, flag sample recoveries as attributable to matrix effects 4) If still out of control, flag associated sample
		Internal standard	Every sample, method blank, and QC sample	RT must be ±30 sec. from last calibration and area must be -50 to 100%	1) Check for malfunctions, and 2) Rerun to confirm matrix interference and then flag data
8270 (GC/MS)	Semivolatile Organics	Field Equipment blank	1 each day of water sampling	≤ 3 x MDL	No laboratory corrective action required
		Duplicate field sample	10%	RPD ≤ 30% (W) RPD ≤ 40% (S)	No laboratory corrective action required
		Laboratory			
		Method blank (Extraction blank)	1 per batch	≤ MDL except for common laboratory contaminants which may be 3 x MDL	1) Evaluate system; run system blank, or 2) Reanalyze, or 3) Reextract/reanalyze if necessary
		Laboratory control sample	5%	See Table 10-1	1) Check calculations, or 2) Rerun, or 3) Reprepare and/or reanalyze method blank and all samples associated with it if appropriate
		Matrix spike sample	5%	See Table 10-2	1) Evaluate system 2) Check calculations 3) Check laboratory control sample; if recoveries within limits, flag matrix spike recoveries as attributable to matrix effects

TABLE 10-3. SUMMARY OF INTERNAL QUALITY CONTROL PROCEDURES ARI
(Page 6 of 6)

Method	Parameter	QC Performed	Frequency[a]	Acceptance Criteria	Corrective Action
8270 (GC/MS) (Cont.)	Semivolatile Organics (Cont.)	Matrix spike duplicate sample	5%	See Table 10-2	Same as matrix spike
		Surrogate spikes	Every sample, method blank, and QC sample	See Table 10-2	1) Check calculations 2) Check laboratory control sample 3) Reanalyze; if recoveries within limits, flag sample recoveries as attributable to matrix effects 4) If still out of control, flag associated sample
		Internal standard	Every sample, method blank, and QC sample	RT must be ±30 sec. from last calibration and area must be -50 to 100%	1) Check for malfunctions, and 2) Rerun to confirm matrix interference and then flag data
9060 Modified	Total Organic Carbon	**Field** Equipment blank	1 each day of water sampling	≤ 3 x MDL	No laboratory corrective action required
		Duplicate field sample	10%	RPD ≤ 30% (W) RPD ≤ 40% (S)	No laboratory corrective action required
		Laboratory Method blank	1 per batch	≤ 3 x MDL	1) Evaluate system; run system blank, or 2) Reanalyze, or 3) Reextract/reanalyze if necessary
		Laboratory control sample	5%	See Table 10-1	1) Check calculations, or 2) Rerun, or 3) Reprepare and/or reanalyze laboratory control sample and all samples associated with it if appropriate
		Matrix spike	5%	See Table 10-2	Flag matrix spike recoveries as attributable to matrix effects
		Matrix spike duplicate	5%	See Table 10-2	Same as MS

[a] Frequencies for duplicate samples and field blanks are computed based on the number of samples taken and the number of analyses specified in the Statement of Work.

[b] EPA Method 8150 will be performed for 2,4,5-TP (Silvex) and 2,4-D as specified for Toxicity Characteristic Leachate Procedure waste characterization only.

11.0 PERFORMANCE AND SYSTEMS AUDITS

A QA audit is an independent assessment of the measurement system. The purpose of the performance audit is to qualitatively and quantitatively assess the data output generated at any level within the system during the data collection for the RI/FS work effort at Kotzebue LRRS. The results of the audit are formulated into a report detailing the overall system performance and deficiencies, plus any recommendations.

11.1 QUALITY ASSURANCE AUDITS

The Tetra Tech, Inc. Project QA/QC Manager and/or the QA Auditor will perform the QA performance and systems audits for the RI/FS work effort associated with Kotzebue LRRS. The QA auditor must be functionally independent of the work effort to ensure objectivity because there will be a requirement for independent assessments of the system and associated data quality. The QA Auditor will be able to identify components of the system which are critical to overall data quality; the QA Auditor should have a technical background and experience that enables an objective and accurate development of audit objectives, design, and interpretation.

11.2 FIELD AUDITS

Periodic audits of field activities of both Tetra Tech, Inc. staff and subcontractors will be performed by the Tetra Tech, Inc. QA Field Auditor or QA staff member. The QA audits will be conducted as soon as possible after a project phase begins. The function of the field QA audit will be to:

- Observe procedures and techniques used in the various measurement efforts, including field sampling and analysis;

- Check and verify instrument and sampling equipment calibration records are in place;
- Assess the effectiveness of and adherence to the prescribed QA procedures;
- Review document control and Chain-of-Custody procedures including the completion of the Chain-of-Custody form;
- Review the completeness of data forms and notebooks;
- Review any nonconformance reporting procedures;
- Identify any weakness in the sampling/analytical approach and techniques; and
- Assess the overall data quality of the various sampling/analytical system employed at the time of the audit.

Based on the audit results, the Tetra Tech, Inc. QA Field Auditor may, as necessary, initiate corrective action at the project level through the QA/QC Project Manager to the Project Manager. A checklist for relevant components of the audit will be filled out by the QA Auditor during the audit. Examples of the general sampling are shown in Figure 11-1. Upon completion of the audit, the QA Auditor will discuss any specific weakness or nonconformances with the field team and make recommendations for corrective actions. An audit report will be prepared to include the relevant checklist and distributed to the Tetra Tech, Inc. QA/QC Project Manager and Project Manager. This report will outline the audit approach and present a summary of results and recommendations. The Program Manager is responsible for responding to any deficiencies.

11.3 LABORATORY AUDITS

11.3.1 Internal Audits

At least once during the project, Tetra Tech, Inc.'s Project QA/QC Manager and/or QA Auditor will visit ARI and other laboratories under contract for this program and verify that this QAPP, as well as the

ENVIRONMENTAL SAMPLING
SYSTEMS AUDIT CHECKLIST
RI/FS, KOTZEBUE LRRS

Contract: ______________________ Date: ______________________

Site: ______________________ Auditor: ______________________

Yes	No	Comments	Operation
			PRESAMPLING OPERATIONS
___	___	___________	1. Sample type? (specify)
___	___	___________	2. Qualified personnel?
___	___	___________	3. Adequate facilities, equipment, and supplies?
___	___	___________	4. Sampling locations properly specified?
___	___	___________	5. Copy of task instructions or QAPP? Revision #_____
___	___	___________	6. Copy of daily sampling schedule?
			SAMPLING OPERATIONS
___	___	___________	1. Samples collected at proper sampling locations?
___	___	___________	2. Rinse probe with DI H_20 prior to placement?
___	___	___________	3. Purge appropriate volume prior to sampling (3 well volumes) For this well #____ = _____ gallons.
___	___	___________	4. Appropriate sample technique used to obtain representative sample?
___	___	___________	5. Appropriate techniques used to ensure sample integrity and avoid contamination?
___	___	___________	6. At least 10% duplicate samples collected?

Figure 11-1. Environmental Sampling Systems Audit Checklist Samples Collected During the RI/FS Investigation of Kotzebue LRRS. (page 1 of 2)

Yes	No	Comments	Operation
____	____	____________	7. Sufficient volume of sample collected?
____	____	____________	8. Suitable sample container used for storage?
____	____	____________	9. Sample bottles properly labeled?
____	____	____________	10. Sampling data sheet completed in a timely manner? (Within five minutes of activity.)
____	____	____________	11. OVA measurements taken and recorded prior to sampling and every 30 minutes during sampling?
			POST-SAMPLING OPERATIONS
____	____	____________	1. Decontamination performed according to current procedure? (Soap, potable water, Type II, reagent grade water, methanol, hexane.)
____	____	____________	2. Well capped immediately following removal of pump and prior to decontamination?
____	____	____________	3. Sampling date, time, and location properly recorded in logbook?
____	____	____________	4. Suitable sample shipping container label used?
____	____	____________	5. Chain-of-Custody form filled out?
____	____	____________	6. Chain-of-Custody seal affixed to sample container?
____	____	____________	7. Refrigerated sample storage?
____	____	____________	8. Overall recordkeeping procedure adequate?

Additional comments: ____

____

____

____

Figure 11-1. Environmental Sampling Systems Audit Checklist Samples Collected During the RI/FS Investigation of Kotzebue LRRS. (page 2 of 2) appropriate sections of the *Handbook* are being adhered to. The audit will occur within the first two weeks of receiving samples to ensure that deficiencies can be corrected early in the program. All relevant components of this QAPP, and the *Handbook*, and their application to ARI analyses of environmental samples collected during the RI/FS work effort will be reviewed.

Tetra Tech, Inc. will perform 5 percent raw data audits onsite at ARI. During that data audit, the raw data, such as chromatograms and calculations, will be compared to previously submitted final data packages for consistency and accuracy. Included in the raw data audit, manual integration of quality control and other samples will be reviewed as well as verification of the instrument specific internal clock. Tetra Tech, Inc. will submit 10 percent of the final data generated during the RI/FS work effort at Kotzebue LRRS to a third-party validator. Third-party validation offers an impartial assessment of previously reviewed/validated data. These packages will be in the U.S. Air Force Level II CLP-equivalent format.

11.3.2 Performance Evaluation Check Samples-ARI

ARI participates in the following performance evaluation (PE) sample programs:

- EPA Semiannual Drinking Water Performance Check Samples (WS Samples);
- EPA Semiannual Wastewater Performance Check Samples (WP Series);
- EPA Certified Laboratory Program (CLP) quarterly blind sample program for organic analysis;
- Analytical Products Group (APG) P.E.T. blind sample program;
- Department of Energy Quality Assessment Program for Radiochemistry; and
- USEPA NRA-RADQA Performance Evaluations for Radiochemistry.

ARI also receives PE samples on a periodic basis from various clients.

Periodically during any sampling round, commercially available PE samples will be forwarded to ARI as part of Tetra Tech, Inc.'s blind sample auditing program. This program provides an external auditing function via PE samples to assess the analytical performance of any laboratory under contract to Tetra Tech, Inc. for a non-CLP statement of work.

11.3.3 Certification Programs-ARI

ARI is certified by the following state and federal agencies:

- State of Washington, Department of Ecology - Environmental Laboratory Accreditation Program;
- State of Alaska, Department of Environmental Conservation;
- State of Washington, Department of Health - Drinking Water Certification Program;
- State of California - Environmental Laboratory Accreditation Program;
- United States Army Corps of Engineers (US ACOE);
- United States Naval Energy and Environmental Support Activity (NEESA);
- Battelle Northwest Laboratories;
- State of Washington, Radiation Protection Division - Radioactive Materials License; and
- Hazardous Waste Remedial Actions Program (HAZWRAP) (US Dept. of Defense).

12.0 PREVENTIVE MAINTENANCE

12.1 MAINTENANCE RESPONSIBILITIES

ARI maintains service contracts for analytical instruments including balances, and inductively coupled plasma spectrometer. Maintenance on chromatographs, graphite furnaces, and mass spectrometers is performed by ARI personnel. All instruments and equipment receive routine preventive maintenance, which is recorded in instrument specific maintenance logs. Routine maintenance ensures that the equipment is operating under optimum conditions, reducing the possibility of instrument malfunction.

12.2 MAINTENANCE SCHEDULES

Preventive maintenance procedures including lubrication, source cleaning, detector cleaning, and the frequency of such maintenance are performed according to the procedures recommended in the manufacturer's instrument user manual.

Chromatographic carrier gas purification traps, injector liners, and injector septa are cleaned or replaced on a regular basis. Precision and accuracy data are examined for trends and excursions beyond control limits to determine evidence of instrument malfunction. Maintenance must be performed when the instrument begins to degrade as evidenced by the degradation of peak resolution, shift in calibration curves, decreased sensitivity, or failure to meet one or another of the quality control criteria. Instrument logbooks containing maintenance and repair records are kept in the laboratories at all times.

12.3 SPARE PARTS

The laboratories also maintain adequate supplies of spare parts such as GC columns, syringes, septa, injection port liners, and electronic parts to minimize potential down-time.

In the event of equipment malfunction that cannot be readily resolved by laboratory personnel, service is obtained from the instrument vendor or manufacturer. Should instrument failure preclude completion of analyses within contract requirements (i.e., holding times), the ARI Project Manager will contact Tetra Tech to determine alternative strategies.

13.0 PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

The two aspects of data quality of primary concern to Tetra Tech, Inc.'s data validation staff are precision and accuracy. Precision is a measure of mutual agreement among individual measurements of the same property under prescribed similar conditions. Accuracy reflects the degree to which the measured value represents the actual or "true" value for a given parameter among individual measurements of the same property under prescribed similar conditions. The completeness of the data will be evaluated based upon the percentage of valid data relative to the total tests requested. How these data quality parameters are assessed by ARI Quality Assurance staff, as well as Tetra Tech, Inc.'s data review/validation staff, is discussed in Section 1.0 of this QAPP.

Laboratory-established criteria for evaluating the precision and accuracy of the data are presented in Table 10-1 for ARI, the laboratory control samples and surrogates. Table 10-2, details the MS/MSD, internal standard and surrogate QC limits to be used by ARI. Percent recovery and relative percent difference control limits for each method, matrix, and spiking compound are also described in these tables. Tables 10-1 and 10-2 also contain the concentration of spiking analytes for ARI.

14.0 CORRECTIVE ACTION

14.1 FIELD ACTIVITIES

During the work effort at Kotzebue LRRS, the Tetra Tech, Inc. Project Manager and sampling team members will be responsible to ensure that all procedures are followed as specified and that measurement data meet the prescribed acceptance criteria. If a problem arises, prompt action must be taken to correct it. Engineering and scientific calculations will be checked and corrected as required by technical personnel, and will not as a rule require QA reporting.

A nonconformance exists if there is a deviations from or a noncompliance with contract specifications, approved procedures, the *Handbook*, or this QAPP. Nonconformance also includes major errors in documented analysis, data, or results, and deficiencies in documentation of any other aspect of the project that may affect the quality of the results. Personnel who identify a nonconformance shall immediately report both verbally and in a written report the condition to the Tetra Tech, Inc. Project QA/QC Manager who will review the report. Based on an evaluation of the nonconformance, the following activities will result:

- Work on the specific task will stop and corrective actions will be taken; or
- If the nonconformance involves a major deviation from the contract or client-approved Work Plan or Sampling and Analysis Plan which may adversely affect the cost schedule of the work, the client will be notified of the nonconformance; or
- If the nonconformance has adversely affected previously gathered data, the Tetra Tech, Inc. Project Manager will complete Part 2 of the Nonconformance Report and notify in writing all individuals and organizations that may be affected by the nonconformance and resulting data.

As a result of the nonconformance, a formal Quality Deficiency Notice may be established to address problems identified through independent QA audits. Figure 14-1 represents an example of a Quality Deficiency Notice. Each Quality Deficiency Notice will address a specific problem or deficiency, usually identified during the QA audit of laboratory project operations. Any Quality Deficiency Notice issued along with the corresponding responses will be tracked. If there is no satisfactory response to a Quality Deficiency Notice within a 30-day time frame, or if there is a dispute concerning the corrective action, the recommendation and/or conflict will be referred to successively higher management levels until the issue is resolved.

A system for issuing a formal Quality Deficiency Notice will be established to address problems identified through independent QA audits. Figure 14-1 represents an example of a Quality Deficiency Notice (QDN). Each Quality Deficiency Notice will address a specific problem or deficiency, usually identified during the QA audit of laboratory or project operations. Any Quality Deficiency Notice issued along with the corresponding responses will be tracked. If there is no satisfactory response to a QDN within a 30 days, or if there is a dispute concerning the corrective action, the recommendation and/or the conflict will be referred to successively higher management levels until the issue is resolved.

14.2 LABORATORY ACTIVITIES

The type and level of corrective action for laboratory activities will depend on the degree of nonconformity. Corrective action may be initiated and carried out by nonsupervisory staff, but final approval and data review by management is necessary before reporting any information. All potentially affected data must be thoroughly reviewed for acceptance or rejection.

When errors, deficiencies, or out-of-control situations arise, the QA program systematically implements "corrective actions" to resolve the problem and restore proper functioning to the analytical system.

Laboratory personnel are alerted that corrective actions may be necessary if the following are observed with respect to analytical results:

Quality Deficiency Notice

1. QDN number ______________________

2. Project ______________________ 3. Project Number ______________________

4. Activity ______________________ 5. Location ______________________

6. Controlling document ______________________

7. Requirement ______________________

8. Description of Deficiency ______________________

9. Reported by ______________________ 10. Date ______________________

11. Discussed with ______________________ 12. Date ______________________

Response:

13. This section to be completed by responsible organization and returned to Tetra Tech, Inc. QA by ______________ (Date).

14. Corrective action (including action to prevent recurrence and root cause determination).

15. Scheduled completion date __________ 16. Signed ______________ Date ________

Page 1 of 2

Figure 14-1 Quality Deficiency Notice, Tetra Tech, Inc. (page 1 of 2)

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Quality Deficiency Notice

Evaluation of response: QDN number ______________

17. This section to be completed by quality assurance department

First response ☐ Satisfactory ☐ Unsatisfactory

Remarks ______________________________

______________ Evaluated by ______________ Date ________

Second response ☐ Satisfactory ☐ Unsatisfactory

Remarks ______________________________

______________ Evaluated by ______________ Date ________

Third response ☐ Satisfactory ☐ Unsatisfactory

Remarks ______________________________

______________ Evaluated by ______________ Date ________

18. Corrective action verified ☐ Yes ☐ N / A

Remarks ______________________________

____

____

____

____

Verified by ______________ Date ________

19. Quality deficiency notice closed on ______________________

By ______________________

Page 2 of 2

Figure 14-1 Quality Deficiency Notice, Tetra Tech, Inc. (page 2 of 2)

H-608012

- QC data are outside the acceptable window for precision and accuracy determination;

- QC samples such as the method blank or the Laboratory Control Sample contain contamination above previously described acceptable levels;

- Undesirable trends are detected in spike recoveries or in the RPDs between the QC sample and appropriate duplicate sample;

- Unusual changes occur in detection limits;

- Deficiencies are detected by the QA/QC Department during internal or external audits of the laboratory and/or deficiencies are detected from the results of performance evaluation samples submitted by Tetra Tech, Inc.; and

- Client inquiries regarding the quality of laboratory-generated results.

Corrective action procedures can usually be handled by the chemist, who reviews the preparation and extraction procedures for errors and checks the instrument calibration, instrument sensitivity, and ancillary equipment associated with the instrument. If the problem persists or cannot be identified after all possible sources of errors are investigated, the matter is then referred to the QA group in the form of a Corrective Action Log or a QA Concern Form (Figures 14-2 and 14-3). The QA group will review the reports and submit an Audit Finding Corrective Action Request (Figure 14-4). Resolution and actions taken will be documented and verified through a follow-up audit. The reports are maintained in the QA files. The Corrective Action Report is also maintained in the project folder. Copies of the completed reports are forwarded to Tetra Tech, Inc.'s QA/QC Project Manager.

Recommended holding times for samples are monitored closely. If a sample is unintentionally analyzed outside a holding time, the Corrective Action Report is used to report any holding time violations (Figure 14-2). The Project Manager will immediately notify Tetra Tech, Inc.'s Project Manager and Project QA/QC Officer of the holding time violation by phone, followed up by a hard-copy of the completed Corrective Action Report by both facsimile and first-class mail. Samples mishandled by ARI may be resampled at ARI's cost if holding times are exceeded prior to either extraction or analysis of the environmental sample.

Corrective Action Log

Today's Date:	Job Number:
Analyst:	Instrument/Analysis:

Date of out-of-control event:

Criteria flagged (check all that apply):

- Control chart action limits: ☐
- Unacceptable spike: ☐
- Unacceptable duplicate: ☐
- Unacceptable internal stds: ☐
- Dilutions don't agree: ☐
- Blank outside criteria: ☐
- Outside surrogate limits: ☐
- Noise/baseline drift: ☐
- Instrument malfunction: ☐
- Other: ☐

Details of problem:

☐ Reextraction needed

Parameter: ______

use back of page if needed

Samples affected:

Specifics on Diagnostics/reestablishment of control:

Include information on sample reanalysis dates:

use back of page if needed

Analyst Signature: ____________________ Date: ____________

Supervisor Signature: ____________________ Date: ____________

Analytical Resources, Inc. *4/91*

Figure 14-2 Corrective Action Log, ARI

ARI QA/QC CONCERN FORM

To help ensure that ARI's quality assurance program is comprehensive and complete, input from staff is encouraged. Any concerns or recommendations for improvement of data quality should be brought to the attention of the Quality Assurance Manager as soon as possible. The QA Manager will review all input within two working days, consulting with ARI Management as appropriate. The QA Manager will then provide a response to the originator within five working days. Confidentiality will be respected.

SUBMITTED BY:

QA/QC CONCERN: Date:
MANAGEMENT REVIEW AND RECOMMENDATION: Date:
QA MANAGER'S RESPONSE: Date:

<< SUBMIT COMPLETED FORM TO MICHELLE TURNER FOR ACTION >>

Document No.: 030F

Revision 0
7/30/93

Figure 14-3 QA/QC Concern Form, ARI

H-003/014 3/15/94

ANALYTICAL RESOURCES INCORPORATED

LABORATORY AUDIT FINDING
CORRECTIVE ACTION REQUEST

No: ______________________________ Date: ______________

Auditor: ____

Audit Date: ______________

Description of Finding:

____

____

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____

____

Recommended Corrective Action:

____

____

____

____

Assigned To: ______________________ Date Required: ______________

Corrective Action Taken:

____

____

____

____

Completed By: ______________________ Date: ______________

Follow-Up Audit to Verify Implementation:

Auditor: ______________________ Date: ______________

Result of Audit:

____

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1009F

Revision 0
12/28/88

Figure 14-4 Audit Finding Corrective Action Request, ARI

H-003016

15.0 QUALITY ASSURANCE REPORTS

Effective management of a field sampling and analytical effort requires timely assessment and review of field and laboratory activities. Such assessment and review will require effective interaction and feedback between Tetra Tech, Inc.'s field sampling team, the Project Manager, the Project QA/QC Manager, and the QA Officer of ARI. Specific report procedures and contents are summarized below.

Sampling and analysis field operations will be reviewed by staff members responsible for the activity to determine if the sampling QC requirements are being fulfilled. ARI QA staff and Project Manager are responsible for keeping Tetra Tech, Inc.'s Project QA/QC Manager and Project Manager up to date regarding the status of their respective tasks. This procedure ensures that solutions are developed and implemented as quickly as possible.

The QA Auditor will include the following elements in a report detailing the status of the system data quality:

- Activities and general program status;
- Calibration and QC problems;
- Unscheduled maintenance activities;
- Corrective action activities;
- Status of any unresolved problems;
- Assessment and summary of data completeness; and
- Significant QA/QC problems and recommended and/or implemented solutions.

The QA Auditor will prepare audit reports following each performance and system audit. These reports will address the audit results and provide a qualitative assessment of overall system performance. They will be submitted to the QA Officer and the Laboratory Manager, and to Tetra Tech, Inc.'s Program QA/QC Manager, Project QA/QC Manager, and the Project Manager.

The final QA/QC report to be generated upon completion of the RI/FS investigation of Kotzebue LRRS will contain an analysis of the QA/QC used to assess the quality of data generated during both field and laboratory operations. The purpose of the final report is to allow evaluation of whether data quality objectives stated in Section 4.0 of this document have been met or not. Based on these results, usability of the data for human health and ecological risk assessment purposes can be evaluated.

If problems requiring swift resolution arise, the Tetra Tech, Inc. Program Manager will be informed and the nonconformance reporting/corrective actions discussed in Section 14.0 of this document will be implemented.

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APPENDIX A - PQLs and MDLs for ARI

ANALYTICAL RESOURCES INCORPORATED

MDL Study - ICP Metals in Water (method 6010)

Date: 06/93

Compound	MDL	PQL
Silver	0.001	0.004
Aluminum	0.01	0.03
Arsenic	0.03	0.1
Boron	0.02	0.05
Barium	0.004	0.01
Beryllium	0.0002	0.001
Calcium	0.02	0.07
Cadmium	0.006	0.02
Cobalt	0.003	0.01
Chromium	0.002	0.006
Copper	0.001	0.002
Iron	0.006	0.02
Potassium	0.2	0.5
Magnesium	0.01	0.04
Manganese	0.003	0.01
Molybdenum	0.002	0.007
Sodium	0.07	0.2
Nickel	0.006	0.02
Lead	0.01	0.042
Antimony	0.03	0.1
Selenium	0.03	0.1
Silica	0.1	0.4
Thallium	0.01	0.04
Vanadium	0.001	0.004
Zinc	0.009	0.03

MDL units are parts per million (mg/L)

MGT 3/31/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Graphite Furnace AA Metals in Water (methods 7421, 7460, 7740)

Date Analyzed: 06/93

Compound	MDL	PQL
Arsenic	0.0004	0.001
Lead	0.001	0.004
Selenium	0.0009	0.003

MDL units are parts per million (mg/L)

MGT 4/4/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Mercury in Water by CVAA (method 7470)

Date: 02/15/94

Compound	MDL	PQL
Mercury	0.00002	0.00006

MDL units are parts per million (mg/L)

MCJT 3/31/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Iron in Water (method 3500)

Date: 03/30/94

Compound	MDL	PQL
Ferrous Iron	0.015	0.05

MDL units are parts per million (mg/L)

MGT 3/31/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Volatile Organics in Water (method 8260)

Instrument: Finn 1
Date: 03/17/94

Compound	MDL	PQL
Chloromethane	1.03	3
Vinyl Chloride	0.52	2
Bromomethane	0.42	2
Chloroethane	0.59	2
Trichlorofluoromethane	0.31	1
Acrolein	3.24	10
Acetone	2.90	9
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.37	1
1,1-Dichloroethene	0.71	2
Bromoethane	0.35	1
Iodomethane	0.99	3
Methylene Chloride	0.41	1
Carbon Disulfide	0.40	2
Acrylonitrile	0.96	3
trans-1,2-Dichloroethene	0.42	1
Vinyl Acetate	0.52	2
1,1-Dichloroethane	0.50	2
Butanone	0.52	2
2,2-Dichloropropane	0.87	3
cis-1,2-Dichloroethene	0.43	2
Chloroform	0.26	1
Bromochloromethane	0.21	1
1,1,1-Trichloroethane	0.54	2
1,1-Dichloropropene	0.58	2
Carbon Tetrachloride	0.42	2
1,2-Dichloroethane	0.69	2
Benzene	0.42	2
Trichloroethene	0.18	1
1,2-Dichloropropane	0.48	2
Bromodichloromethane	0.44	2
Dibromomethane	0.50	2
2-Chloroethyl Vinyl Ether	0.82	3
4-Methyl-2-Pentanone	1.22	4
cis-1,3-Dichloropropene	0.38	1
Toluene	0.46	2
trans-1,3-Dichloropropene	0.48	2
1,1,2-Trichloroethane	0.42	1
1,2-Dibromoethane	0.27	1
2-Hexanone	0.72	2
1,3-Dichloropropane	0.34	1
Tetrachloroethene	0.30	1
Chlorodibromomethane	0.24	1
Chlorobenzene	0.20	1
1,1,1,2-Tetrachloroethane	0.46	2

Compound	MDL	PQL
Ethyl Benzene	0.28	1
m,p-Xylene	0.50	2
o-Xylene	0.18	1
Styrene	0.08	1
Bromoform	0.47	2
Isopropyl Benzene	0.28	1
1,1,2,2-Tetrachloroethane	0.56	2
1,2,3-Trichloropropane	0.41	1
trans-1,4-Dichloro-2-Butene	0.75	2
n-Propyl Benzene	0.29	1
Bromobenzene	0.43	2
1,3,5-Trimethylbenzene	0.50	2
2-Chlorotoluene	0.67	2
4-Chlorotoluene	0.30	1
t-Butylbenzene	0.36	1
1,2,4-Trimethylbenzene	0.24	1
s-Butylbenzene	0.44	1
4-Isopropyl Toluene	0.29	1
1,3-Dichlorobenzene	0.36	1
1,4-Dichlorobenzene	0.43	1
n-Butylbenzene	0.23	1
1,2-Dichlorobenzene	0.30	1
1,2-Dibromo-3-Chloropropane	0.91	3
1,2,4-Trichlorobenzene	0.40	1
Hexachloro-1,3-Butadiene	0.56	2
Naphthalene	0.69	2
1,2,3-Trichlorobenzene	0.72	2

MDL units are parts per billion (µg/L)

MGT 3/31/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Volatile Organics in Soil/Sediment (method 8260)

Instrument: Finn 1
Date: 3/31/94

Compound	MDL	PQL
Chloromethane	0.0009	0.003
Vinyl Chloride	0.0010	0.003
Bromomethane	0.0008	0.003
Chloroethane	0.0010	0.003
Trichlorofluoromethane	0.0008	0.002
Acrolein	0.0094	0.03
Acetone	0.0039	0.01
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.0007	0.002
1,1-Dichloroethene	0.0012	0.004
Bromoethane	0.0007	0.002
Iodomethane	0.0011	0.003
Methylene Chloride	0.0009	0.003
Carbon Disulfide	0.0005	0.002
Acrylonitrile	0.0010	0.003
trans-1,2-Dichloroethene	0.0009	0.003
Vinyl Acetate	0.0016	0.005
1,1-Dichloroethane	0.0004	0.001
Butanone	0.0025	0.008
2,2-Dichloropropane	0.0007	0.002
cis-1,2-Dichloroethene	0.0011	0.004
Chloroform	0.0005	0.001
Bromochloromethane	0.0038	0.01
1,1,1-Trichloroethane	0.0004	0.001
1,1-Dichloropropene	0.0007	0.002
Carbon Tetrachloride	0.0010	0.003
1,2-Dichloroethane	0.0005	0.002
Benzene	0.0005	0.0015
Trichloroethene	0.0005	0.002
1,2-Dichloropropane	0.0008	0.003
Bromodichloromethane	0.0006	0.002
Dibromomethane	0.0008	0.002
2-Chloroethyl Vinyl Ether	0.0006	0.002
4-Methyl-2-Pentanone	0.0015	0.005
cis-1,3-Dichloropropene	0.0007	0.002
Toluene	0.0009	0.0029
trans-1,3-Dichloropropene	0.0005	0.002
1,1,2-Trichloroethane	0.0007	0.002
1,2-Dibromoethane	0.0010	0.003
2-Hexanone	0.0027	0.009
1,3-Dichloropropane	0.0006	0.002
Tetrachloroethene	0.0009	0.003
Chlorodibromomethane	0.0003	0.001
Chlorobenzene	0.0007	0.002
1,1,1,2-Tetrachloroethane	0.0010	0.003

Compound	MDL	PQL
Ethyl Benzene	0.0004	0.0014
m,p-Xylene	0.0010	0.0030
o-Xylene	0.0011	0.0034
Styrene	0.0006	0.002
Bromoform	0.0013	0.004
Isopropyl Benzene	0.0005	0.002
1,1,2,2-Tetrachloroethane	0.0009	0.003
1,2,3-Trichloropropane	0.0023	0.007
trans-1,4-Dichloro-2-Butene	0.0014	0.004
n-Propyl Benzene	0.0009	0.003
Bromobenzene	0.0007	0.002
1,3,5-Trimethylbenzene	0.0005	0.002
2-Chlorotoluene	0.0008	0.003
4-Chlorotoluene	0.0012	0.004
t-Butylbenzene	0.0004	0.001
1,2,4-Trimethylbenzene	0.0009	0.003
s-Butylbenzene	0.0007	0.0[illegible]
4-Isopropyl Toluene	0.0007	0.002
1,3-Dichlorobenzene	0.0010	0.003
1,4-Dichlorobenzene	0.0009	0.003
n-Butylbenzene	0.0009	0.003
1,2-Dichlorobenzene	0.0008	0.002
1,2-Dibromo-3-Chloropropane	0.0012	0.004
1,2,4-Trichlorobenzene	0.0017	0.005
Hexachloro-1,3-Butadiene	0.0013	0.004
Naphthalene	0.0009	0.003
1,2,3-Trichlorobenzene	0.0014	0.004

MDL units are parts per million (mg/kg)

MGT 3/31/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Semivolatile Organics in Water (method 8270)

Analysis Date: 06/19/93
Instrument: Finn 2

Compound	MDL	PQL
Phenol	0.9	3
Bis (2-Chloroethyl) Ether	1.9	6
2-Chlorophenol	0.2	1
1,3-Dichlorobenzene	0.3	1
1,4-Dichlorobenzene	0.3	1
Benzyl Alcohol	0.7	2
1,2-Dichlorobenzene	0.2	1
2-Methylphenol	0.2	1
2,2'Oxybis (1-Chloropropane)	0.2	1
4-Methylphenol	0.6	2
N-Nitroso Di-N-Propylamine	1.3	4
Hexachloroethane	0.6	2
Nitrobenzene	0.3	1
Isophorone	0.5	2
2-Nitrophenol	0.5	2
2,4-Dimethylphenol	2.6	8
Benzoic Acid	3.1	10
Bis (2-Chloroethoxy)Methane	0.5	2
2,4-Dichlorophenol	1.0	3
1,2,4-Trichlorobenzene	0.2	1
Naphthalene	0.2	1
4-Chloroaniline	2.0	6
Hexachlorobutadiene	0.7	2
4-Chloro 3 Methylphenol	1.1	3
2-Methylnaphthalene	0.6	2
Hexachlorocyclopentadiene	2.9	9
2,4,6-Trichlorophenol	1.5	5
2,4,5-Trichlorophenol	1.3	4
2-Chloronaphthalene	0.5	2
2-Nitroaniline	1.3	4
Dimethyl Phthalate	0.7	2
Acenaphthylene	0.6	2
3-Nitroaniline	5.4	20
Acenaphthene	0.6	2
2,4-Dinitrophenol	8.4	30
4-Nitrophenol	1.6	5
Dibenzofuran	0.6	2
2,6-Dinitrotoluene	1.5	5
2,4-Dinitrotoluene	1.3	4

Compound	MDL	PQL
Diethylphthalate	1.0	3
4-Chlorophenyl Phenylether	0.5	2
Fluorene	0.5	2
4-Nitroaniline	4.5	10
4,6-Dinitro-2-Methylphenol	2.7	9
N-Nitroso Diphenylamine	0.6	2
4-Bromophenyl Phenylether	0.6	2
Hexachlorobenzene	0.6	2
Pentachlorophenol	3.7	10
Phenanthrene	0.6	2
Carbazole	0.6	2
Anthracene	0.7	2
Di N-Butylphthalate	1.0	3
Fluoranthene	0.6	2
Pyrene	0.6	2
Butylbenzylphthalate	0.7	2
3,3'-Dichlorobenzidine	2.1	7
Benzo (A) Anthracene	0.6	2
Bis (2-Ethylhexyl) Phthalate	0.6	2
Chrysene	0.6	2
Di n-Octyl Phthalate	0.6	2
Benzo (B) Fluoranthene	0.6	2
Benzo (K) Fluoranthene	0.8	3
Benzo (A) Pyrene	0.7	2
Indeno (1,2,3-CD) Pyrene	0.5	2
Dibenz (A,H) Anthracene	0.6	2
Benzo (G,H,I)Perylene	0.5	2

MGT 3/31/94

MDL units are parts per billion (µg/L)

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Semivolatile Organics in Sediment (method 8270)

Analysis Date: 06/28/93
Instrument: Finn 2

Compound	MDL	PQL
Phenol	0.05	0.2
Bis (2-Chloroethyl) Ether	0.04	0.1
2-Chlorophenol	0.07	0.2
1,3-Dichlorobenzene	0.04	0.1
1,4-Dichlorobenzene	0.03	0.1
Benzyl Alcohol	0.05	0.2
1,2-Dichlorobenzene	0.04	0.1
2-Methylphenol	0.10	0.3
2,2'Oxybis (1-Chloropropane)	0.03	0.1
4-Methylphenol	0.08	0.2
N-Nitroso Di-N-Propylamine	0.03	0.1
Hexachloroethane	0.04	0.1
Nitrobenzene	0.02	0.1
Isophorone	0.03	0.1
2-Nitrophenol	0.03	0.1
2,4-Dimethylphenol	0.17	0.3
Benzoic Acid	0.06	0.18
Bis (2-Chloroethoxy)Methane	0.04	0.1
2,4-Dichlorophenol	0.04	0.1
1,2,4-Trichlorobenzene	0.03	0.1
Naphthalene	0.04	0.1
4-Chloroaniline	0.10	0.3
Hexachlorobutadiene	0.03	0.1
4-Chloro 3 Methylphenol	0.06	0.2
2-Methylnaphthalene	0.03	0.1
Hexachlorocyclopentadiene	0.03	0.1
2,4,6-Trichlorophenol	0.04	0.1
2,4,5-Trichlorophenol	0.03	0.08
2-Chloronaphthalene	0.03	0.1
2-Nitroaniline	0.02	0.06
Dimethyl Phthalate	0.04	0.1
Acenaphthylene	0.04	0.1
3-Nitroaniline	0.11	0.35
Acenaphthene	0.03	0.1
2,4-Dinitrophenol	0.09	0.28
4-Nitrophenol	0.07	0.21
Dibenzofuran	0.03	0.1
2,6-Dinitrotoluene	0.04	0.1
2,4-Dinitrotoluene	0.02	0.1
Diethylphthalate	0.04	0.1
4-Chlorophenyl Phenylether	0.02	0.1
Fluorene	0.03	0.1
4-Nitroaniline	0.13	0.42
4,6-Dinitro-2-Methylphenol	0.09	0.28

Compound	MDL	PQL
N-Nitroso Diphenylamine	0.08	0.3
4-Bromophenyl Phenylether	0.02	0.1
Hexachlorobenzene	0.03	0.1
Pentachlorophenol	0.03	0.10
Phenanthrene	0.03	0.1
Carbazole	0.06	0.2
Anthracene	0.04	0.1
Di N-Butylphthalate	0.06	0.2
Fluoranthene	0.03	0.1
Pyrene	0.03	0.1
Butylbenzylphthalate	0.02	0.1
3,3'-Dichlorobenzidine	0.06	0.2
Benzo (A) Anthracene	0.04	0.1
Bis (2-Ethylhexyl) Phthalate	0.04	0.1
Chrysene	0.05	0.1
Di n-Octyl Phthalate	0.02	0.1
Benzo (B) Fluoranthene	0.04	0.1
Benzo (K) Fluoranthene	0.07	0.2
Benzo (A) Pyrene	0.04	0.1
Indeno (1,2,3-CD) Pyrene	0.03	0.1
Dibenz (A,H) Anthracene	0.02	0.1
Benzo (G,H,I)Perylene	0.03	0.1

MQT 9/4/94

MDL units are parts per million (mg/Kg)

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Pesticides in Water (method 8081)

Analysis Date: 03/24/94 Column: DB-5
Instrument: ECD-3

Compound	MDL	PQL
Alpha-BHC	0.002	0.01
Beta-BHC	0.002	0.01
Gamma-BHC (Lindane)	0.002	0.01
Delta-BHC	0.002	0.01
Heptachlor	0.004	0.01
Aldrin	0.005	0.02
Heptachlor Epoxide	0.003	0.01
Gamma Chlordane	0.003	0.01
Alpha Chlordane	0.003	0.01
DDE	0.009	0.029
Dieldrin	0.004	0.020
Endrin	0.004	0.014
Endosulfan II	0.007	0.021
DDD	0.005	0.017
Endrin Aldehyde	0.010	0.031
DDT	0.010	0.031
Endrin Ketone	0.006	0.02
Methoxychlor	0.038	0.12

MDL units are parts per billion (µg/L)

MGT 3/31/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Pesticides in Water (method 8081)

Analysis Date: 03/24/94 Column: DB-608
Instrument: ECD-3

Compound	MDL	PQL
Alpha-BHC	0.001	0.01
Beta-BHC	0.003	0.01
Gamma-BHC (Lindane)	0.002	0.01
Delta-BHC	0.002	0.01
Heptachlor	0.004	0.01
Aldrin	0.010	0.03
Heptachlor Epoxide	0.002	0.01
Gamma Chlordane	0.003	0.01
Alpha Chlordane	0.004	0.01
DDE	0.010	0.032
Dieldrin	0.005	0.015
Endrin	0.004	0.013
Endosulfan II	0.005	0.015
DDD	0.004	0.014
Endrin Aldehyde	0.010	0.031
DDT	0.008	0.026
Endrin Ketone	0.006	0.02
Methoxychlor	0.035	0.11
Endosulfan I	0.004	0.012
Endosulfan Sulfate	0.003	0.01

MDL units are parts per billion (µg/L)

NGT 3/31/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Pesticides in Soil (method 8081)

Analysis Date: 03/24/94 Column: DB-5
Instrument: ECD-3

Compound	MDL	PQL
Alpha-BHC	0.00006	0.00020
Beta-BHC	0.00010	0.00031
Gamma-BHC (Lindane)	0.00008	0.00025
Delta-BHC	0.00010	0.00032
Heptachlor	0.00009	0.0003
Aldrin	0.00006	0.00020
Heptachlor Epoxide	0.00008	0.00025
Gamma Chlordane	0.00005	0.00017
Alpha Chlordane	0.00006	0.00020
DDE	0.00010	0.0003
Dieldrin	0.00012	0.0004
Endrin	0.00010	0.0003
Endosulfan II	0.00016	0.0005
DDD	0.00012	0.0004
Endrin Aldehyde	0.00023	0.0007
DDT	0.00023	0.0007
Endrin Ketone	0.00033	0.0010
Methoxychlor	0.00083	0.0027

MDL units are parts per million (mg/kg)

MGT 3/31/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Pesticides in Soil (method 8081)

Analysis Date: 03/24/94   Column: DB-608
Instrument: ECD-3

Compound	MDL	PQL
Alpha-BHC	0.00006	0.00018
Beta-BHC	0.00009	0.00029
Gamma-BHC (Lindane)	0.00007	0.00021
Delta-BHC	0.00007	0.00024
Heptachlor	0.00009	0.00028
Aldrin	0.00008	0.00026
Heptachlor Epoxide	0.00010	0.00032
Gamma Chlordane	0.00008	0.00026
Alpha Chlordane	0.00011	0.00036
DDE	0.00015	0.0005
Dieldrin	0.00015	0.0005
Endrin	0.00010	0.0003
Endosulfan II	0.00016	0.0005
DDD	0.00015	0.0005
Endrin Aldehyde	0.00027	0.0008
DDT	0.00013	0.0004
Endrin Ketone	0.00028	0.0009
Methoxychlor	0.00109	0.0035
Endosulfan I	0.00011	0.00036
Endosulfan Sulfate	0.00025	0.0008

MDL units are parts per million (mg/kg)

OMT 3/31/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Toxaphene in Soil (method 8081)

Analysis Date: 03/30/94
Instrument: ECD-3

DB5

Compound	MDL	PQL
Toxaphene	0.01	0.02

DB608

Compound	MDL	PQL
Toxaphene	0.01	0.03

MDL units are parts per million (mg/kg)

MGT 3/31/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Toxaphene in Water (method 8081)

Analysis Date: 03/30/94
Instrument: ECD-3

DB5

Compound	MDL	PQL
Toxaphene	0.25	0.79

DB608

Compound	MDL	PQL
Toxaphene	0.15	0.46

MDL units are parts per billion (µg/L)

MGT 3/31/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - PCBs in Water (method 8081)

Instrument: ECD 2
Date: 11/02-03/93 DB5 Column

Compound	MDL	PQL
Aroclor 1016	0.3	0.9
Aroclor 1221	0.2	0.8
Aroclor 1232	0.3	0.8
Aroclor 1242	0.2	0.7
Aroclor 1248	0.3	0.8
Aroclor 1254	0.2	1
Aroclor 1260	0.3	1

Instrument: ECD 2 (Second Column Confirmation)
Date: 11/02-03/93 DB608 Column

Compound	MDL	PQL
Aroclor 1016	0.3	0.9
Aroclor 1221	0.2	0.8
Aroclor 1232	0.3	1.1
Aroclor 1242	0.3	1.0
Aroclor 1248	0.2	0.7
Aroclor 1254	0.3	1
Aroclor 1260	0.3	1

MDL units parts per billion (µg/L)

MGT 4/5/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - PCBs in Soil (method 8081)

Instrument: ECD 2
Extraction Date: 03/30/94

DB5

Compound	MDL	PQL
Aroclor 1016	0.009	0.03
Aroclor 1260	0.009	0.03
Aroclor 1254	0.011	0.03
Aroclor 1242	0.005	0.02
Aroclor 1248	0.004	0.01
Aroclor 1221	0.011	0.03
Aroclor 1232	0.005	0.01

DB608

Compound	MDL	PQL
Aroclor 1016	0.009	0.03
Aroclor 1260	0.010	0.03
Aroclor 1254	0.009	0.03
Aroclor 1242	0.008	0.02
Aroclor 1248	0.005	0.02
Aroclor 1221	0.010	0.03
Aroclor 1232	0.005	0.01

MDL units are parts per million (mg/kg)

MGT 4/1/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Total Gasoline in Water
Method AK-101

Analysis Date: 05/22/93
Instrument: PID/FID

Compound	MDL	PQL
Gasoline	0.1	0.4 √

MDL units are parts per million (mg/L)

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - TPH-Gasoline in Soil
Method AK-101

Extraction Date: 11/19/93
Instrument: PID/FID

Compound	MDL	PQL
Gasoline	1.7	6

MDL units are parts per million (mg/kg)

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - TPH Diesel in Water
Method AK-102

Analysis Date: 06/14/93
Instrument: FID-2

Compound	MDL	PQL
Diesel	0.06	0 2

MDL units are parts per million (mg/L)

ANALYTICAL
RESOURCES
INCORPORATED

MDL STUDY - TPH-Diesel in Soil
Method AK-102

Extraction Date: 08/09/93

Compound	MDL	PQL
Diesel	0.9	3

MDL units are parts per million (mg/kg)

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - Total Organic Carbons in Water (method 9060M)

Date: 07/21/94

Compound	MDL	PQL
Total Organic Carbons	0.2	0.6

MDL units are parts per million (mg/L)

MGT 3/31/94

ANALYTICAL
RESOURCES
INCORPORATED

MDL Study - TOC in Soil

Analysis Date: 05/09/94
Instrument: Dohrmann DC-190

Compound	MDL	PQL
TOC	158	561